WORLD PETROLEUM

APRIL 1956

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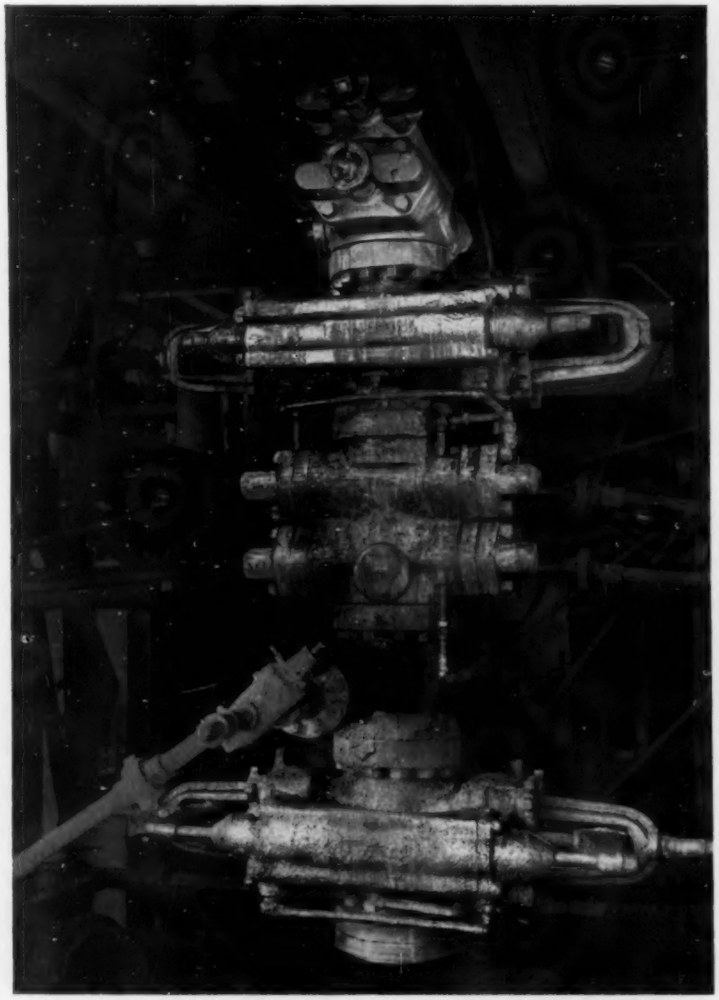

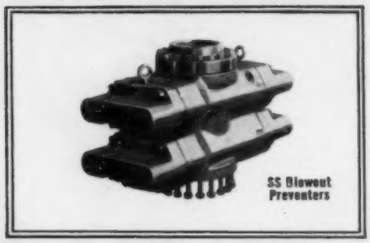

WORLD'S DEEPEST WELL

WORLD'S BEST EQUIPMENT

Hearty Congratulations to:
Richardson and Bass, John W. Mecom and Freeport Sulphur. We are happy to have been a part of their remarkable accomplishment, the LL&E No. 1-L Humble, in the Lake Washington Field of Plaquemine Parish, Louisiana.

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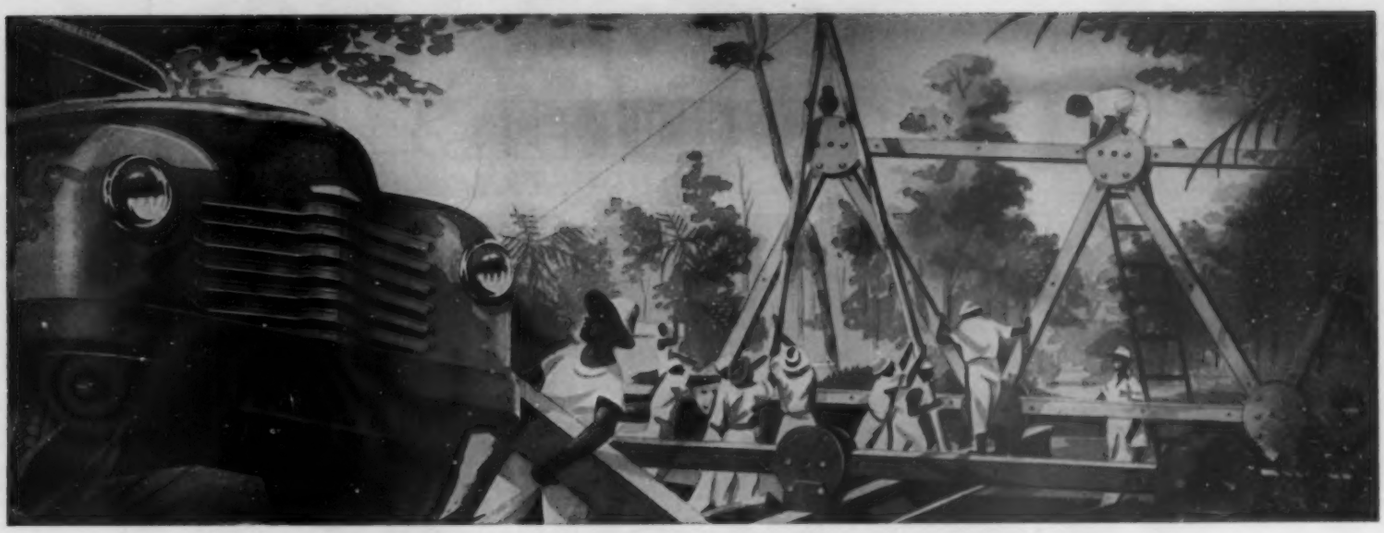

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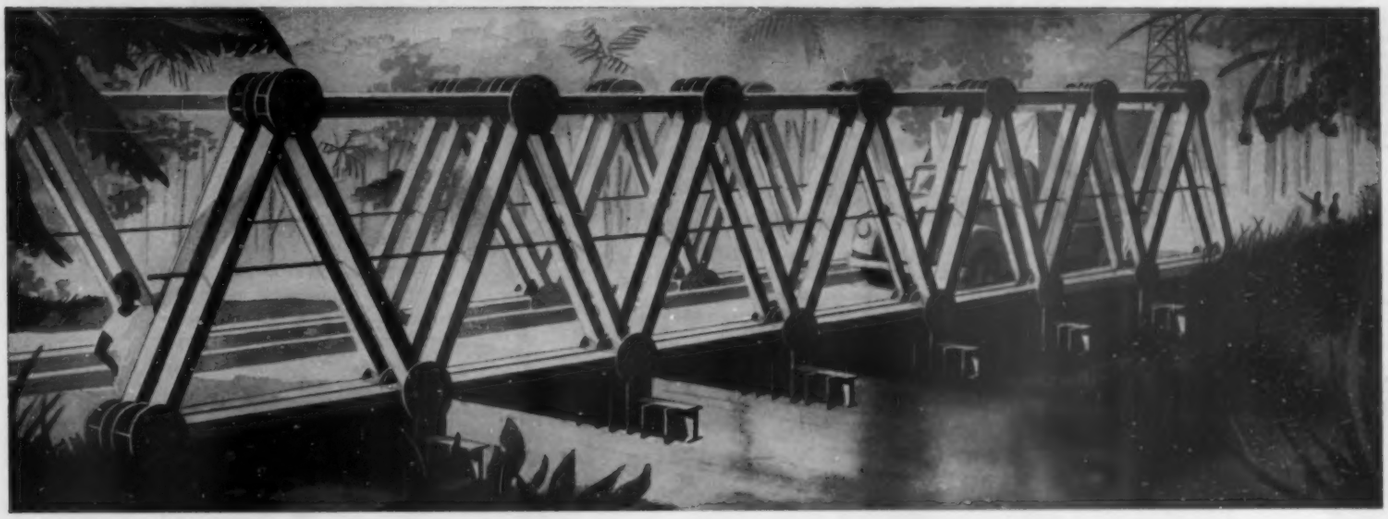

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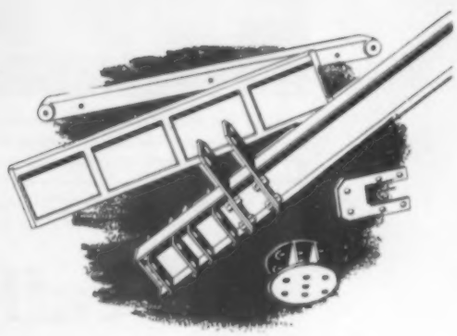
Butterley Standard-Unit Bridges are in use all over the world where transport is difficult, skilled labour scarce or where site preparation has to be carried out under adverse conditions. From five standard units, all sizes of bridges can be built; the units can be sent by any form of transport; site erection is remarkably simple and swift with an absolute minimum of equipment.



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New Services • • • New Tools • • • New Methods • • • Outstanding Results

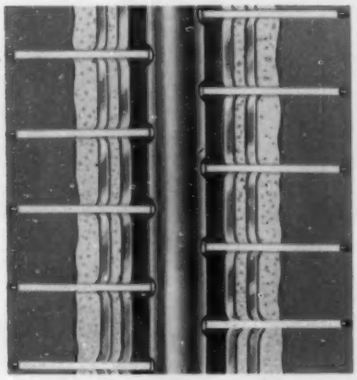
Uniform Hole Pattern in Casing Plus Deep Penetration Means More Barrels of Oil

Among the many benefits of M-3 Bullet Perforating is the uniformity of hole pattern in the casing. This perforating pattern is the same as the chambers in the gun itself. Shots are placed in patterns of staggered rows. This permits the safe use of more holes per foot in the casing, assures complete, uniform coverage of the productive zone, provides maximum drainage area from the formation and eliminates the possibility of bunching all shots in one area in the casing.

A fine example of effective perforating by M-3 Guns was recently reported from Wyoming.

Five inch O.D. 18 lb. liner had been set through the pay at 4300' and was perforated by another service company for 60 barrels of oil per day.

McCullough reperforated with 204 new ½" Burrless Ogival Bullets in three hours rig time. Well was put on the pump for 260 barrels per day—over a 300% increase in production—and has maintained this production after being on the pump for some time.



Improved McCullough M-3 Bullet Perforators fire one to six shots per foot, one to ninety at a time and are placed exactly where they are wanted. Uniform hole pattern plus deepest penetration assures more effective drainage of pay zone—More Oil!

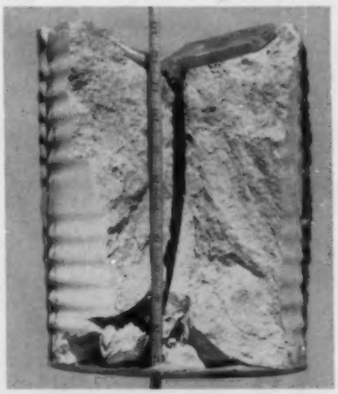
M-3 Bullet Guns Increase Production From 13,000 CF/D to 8 Million CF/D

Deep Penetration Through Thick Cement Sheath Increases Gas Production to 615 Times Previous Rate

The outstanding penetrating ability of improved McCullough M-3 Bullet Perforators was responsible for a startling increase in gas production from a Colorado well, according to a recent job report from the area.

Gas zone was located between 5349' and 5395'. Open hole, in the pay interval, was calipered at 13". 7" O.D. 23 lb. casing was set and cemented through the zone.

This zone had previously been perforated by another service company using the permanent type well completion method, and the well made 13,000 cu. ft. of gas per day.



7" O.D. 26 lb. N-80 casing set in cement and perforated by 4¼" O.D. McCullough M-3 Bullet Perforator. Test sample was standing on a steel plate and ½" Burrless Bullet penetrated entire depth of target and ⅜" into steel plate.

McCullough was called to re-shoot the same zone. Made five runs with improved McCullough 4¼" 20-shot M-3 Guns and fired 184 ½" Burrless Bullets in the 46' gas zone. A considerable increase in gas pressure was recorded after each run. After perforating was completed, the well tested at 8 million cu. ft. of gas per day and has continued to be a good producer.

Penetration like this is not out of the ordinary. M-3 Guns firing the new ogival bullets are capable of penetrating as many as three strings of cemented casing and deep into the productive formation. They give you premium penetration at no extra cost—they get the kind of results you want—greater production with maximum economy.

M-3 GUN PENETRATES CEMENT LEFT BY FIVE SQUEEZE JOBS

Five and one-half inch 17 lb. casing had been set through pay at approximately 6386'. Well had been squeezed five times to obtain W.S.O., leaving a great deal of cement to be penetrated.

Two different makes of jet perforators were fired at the desired depth without results. An improved 4⅜" O.D. McCullough M-3 Bullet Gun fired four shots in the same interval and made a well of 125 barrels per day. Time on job: One hour.

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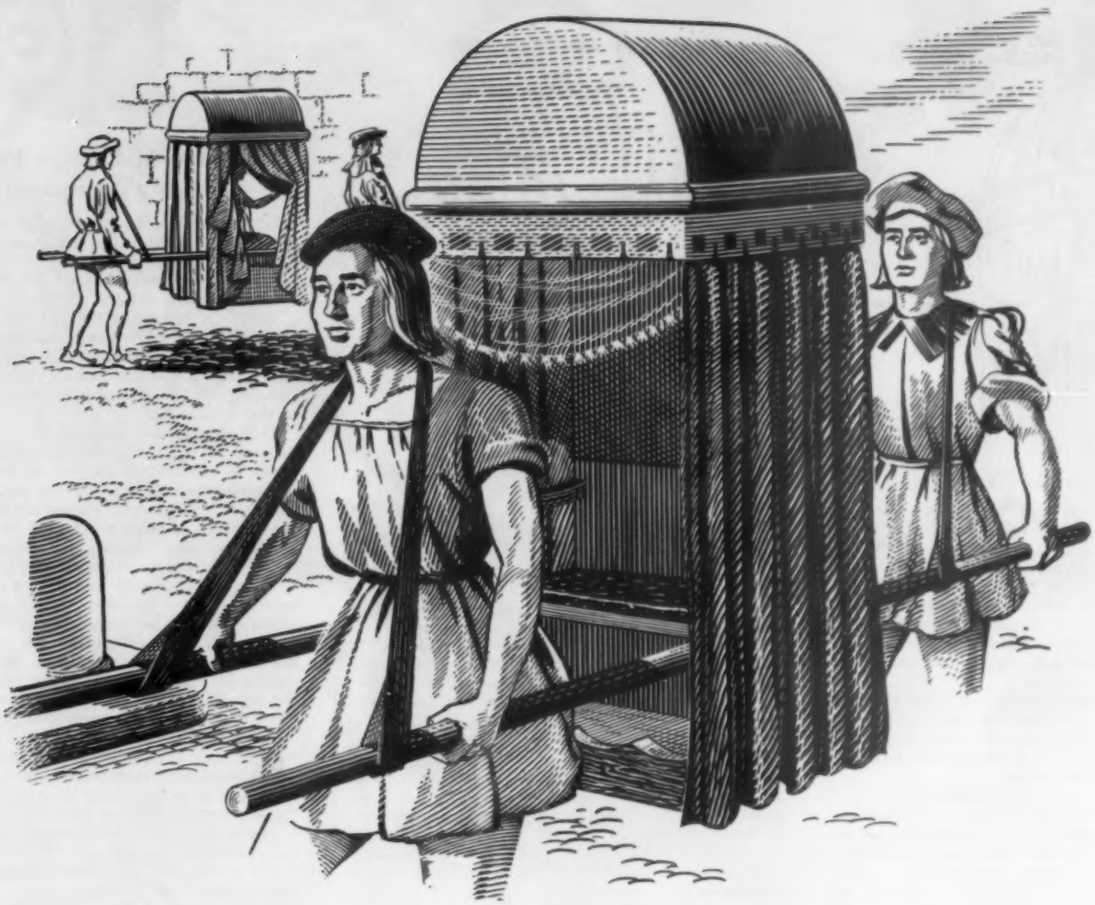

Imagine a traveling world without oil!

Not too long ago, the only barrier to the conquest of time and space was the sound of a pessimist's voice. Today, we have indeed broken through more than one sound barrier . . . and, perhaps, the limits of the imagination are the only limits which remain. Clearly, such an outstanding development derives, in large measure, from petroleum power. It should not be cause for amazement, then, that Caltex, in supplying fine fuels and lubricants to the peoples of 67 free lands, is proudly aware of its vital contribution to international travel.

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Washington PIPE LINE

By Joseph B. Huttlinger

The U. S. petroleum industry is the target of widespread attention from members of the U. S. Congress and of the Eisenhower administration.

Attention is being given to production of crude petroleum and natural gas, pipe lines, refining, marketing, and efforts to influence Congress. Oil imports, oil taxes, gasoline stations, National Petroleum Council, the foreign petroleum supply committee, interstate oil compact and natural gas prices are under study.

The total of attention being given oil and gas is, perhaps, greater than at any one time in the last decade. While it is not clear what will come of it all, there is a certainty that the studies may set up trouble for oil in the future.

Here's a run down on what is going on:

1—The special eight-man Senate committee to study lobbying has named oil and gas as the first candidate for study. The committee was named after President Eisenhower vetoed the bill to remove federal price controls over gas with a blast at an "arrogant" gas lobby. Whether the committee will hit hard is to be seen.

2—The Federal Trade Commission, spurred on by the Senate Small Business Committee, has asked $800,000 for a top-to-bottom study of marketing of gasoline, lubricating oil, tires and batteries. The study would take 18 months, and require 40 economists. Whether the Congress gives the funds or not, the meaning is clear: Some people want to punish oil marketing.

3—The FTC is preparing an antitrust complaint against at least one major oil company on the grounds that its price discounts to selected gasoline dealers in price war areas violate the antitrust laws. The FTC position is that a price cut, if given, should be to all dealers, whether or not in a price war area, or to none. Jacksonville, Fla., has been one area under study by FTC. The FTC case, if FTC wins, would mean a major change in gasoline marketing.

4—The 27.5% income tax depletion allowance is under attack in a rash of new bills. Most of the new bills would reduce the allowance to 15%. Senators Williams, R., Del.; Aiken, R., Vt.; Smith, R., Me.; and Purtell, R., Conn., are making the big push for the 15% in the Senate. They sponsor the WASP bill. While Treasury Secretary George Humphrey has endorsed the depletion allowance theory, the drive to cut the allowance could get out of control.

5—The U. S. Department of Justice has asked many thousands of dollars to study "price fixing" angles of the interstate oil compact commission. A report is due by midyear. Congress asked for the report.

6—Herbert Brownell, Jr., who already has eliminated the industry chairman of the Foreign Petroleum Supply Committee, continues to consider moving against the National Petroleum Council. A government chairman of NPC might mean the end of the council.

7—The Federal Power Commission, which has endorsed legislation to ease up federal price controls over natural gas producers, is faced, due to the President's veto, with the job of carrying out federal price controls. The question is, what is to be the method of price controls? This is a major question before the industry.

There are, in general, two methods of handling price controls. One is to find out what are the costs of finding and producing the gas, and then to allow these costs plus a reasonable return. For gas, which is risky, a reasonable return might be 9%, FPC feels.

The other method is to allow a price which is close to the going market price for gas in the field. According to critics of the gas industry, "this is no price control at all and will not protect consumers." In between, there are a score or more methods of controlling the price, many of them combinations and compromises between "cost-plus" and "going market price."

A majority of the commission is against "cost-plus" on the grounds it just won't work for gas. Yet the law may require this. Cost-plus is the method used for price controls for virtually all public utilities; "it may be applicable" to natural gas producers, according to Chairman Jerome Kuykendall of the commission, "as a matter of law." But, he said, he doubts it will work.

S. L. Digby, one of the five commissioners, asks: are you going to base the costs on "one well" of one producer? Or on all the wells in a reservoir, or field, or over the country of one producer? Or all the wells of all the producers in a reservoir, or field, or state? "If you are going to set up a cost rate base, you first have to determine what cost you are going to consider in calculating that rate base," he told a House Committee after the veto.

The method of price control to be used is a question of paramount importance to natural gas producers. For if cost is to be used, it is absolutely essential that the cost of the crude oil, as well as the cost of the natural gas, be calculated. And this is a foot in the door towards price control.

A year off, a new natural gas bill may be started on its way, so there is a chance that price control over natural gas, which began June 7, 1954, could be ended. But there is no certainty of this. President Eisenhower, in vetoing the natural gas bill, said he is for the aims of the bill; but he did not like the "arrogant" lobbying by some gas producers.

Now, with another election coming up, President Eisenhower is letting out the word that, if reelected, he will initiate new legislation next year to remove the price controls over gas.

This kind of promise is likely to attract campaign contributions in the coming months from oil and gas producers. While some oil men are furious about the veto, they face the stark fact that the Democratic candidates for President are even less favorable to legislation to ease up federal controls over gas producers.

Change In Foreign Petroleum Supply Agreement Staff

Hugh A. Stewart, director of the office of oil and gas of the Department of the Interior, is taking over as chairman of the Foreign Petroleum Supply Agreement formerly headed by Stewart Coleman of the Standard Oil Co. (N. J.).

The shift follows a Feb. 21 ruling by Attorney General Herbert Brownell, Jr., that the committee and its subcommittees have government employees as chairmen. The idea, said Attorney Brownell, is "to minimize" the "anti-competitive consequences" of the agreement.

Secretary of the Interior Douglas McKay was ordered to name the staff of the committee from ranks of government as well as the chairman and subcommittee chairman. In the past, the committee was run by industry, almost exclusively, but the Department of Justice objected to U. S. oil companies abroad swapping information about each other's production, requirements and programs.

The committee will continue to gather data, but members of the committee, generally oil company officials, are to be denied information as to facts and figures about oil production, requirements and the like of competing companies. In fact, where one company handles all oil operations in a country, the figures on this country are to be denied to other members of the committee. Members, further, are barred from furnishing information as to operations of their companies to the committee members.

The committee members "may consult" with the chairmen as to "accuracy of overall statistics," and "supply and demand for certain geographical areas."

At one time, Attorney Brownell was ready to end the committee on the grounds it is a vehicle by which certain oil companies violate the anti-trust laws. Instead, he merely changed the terms. The change came over the objections of Departments of Defense and Interior. The departments saw no antitrust problems, and claimed the work of gathering and evaluating the foreign oil data could not be done under a changed program.

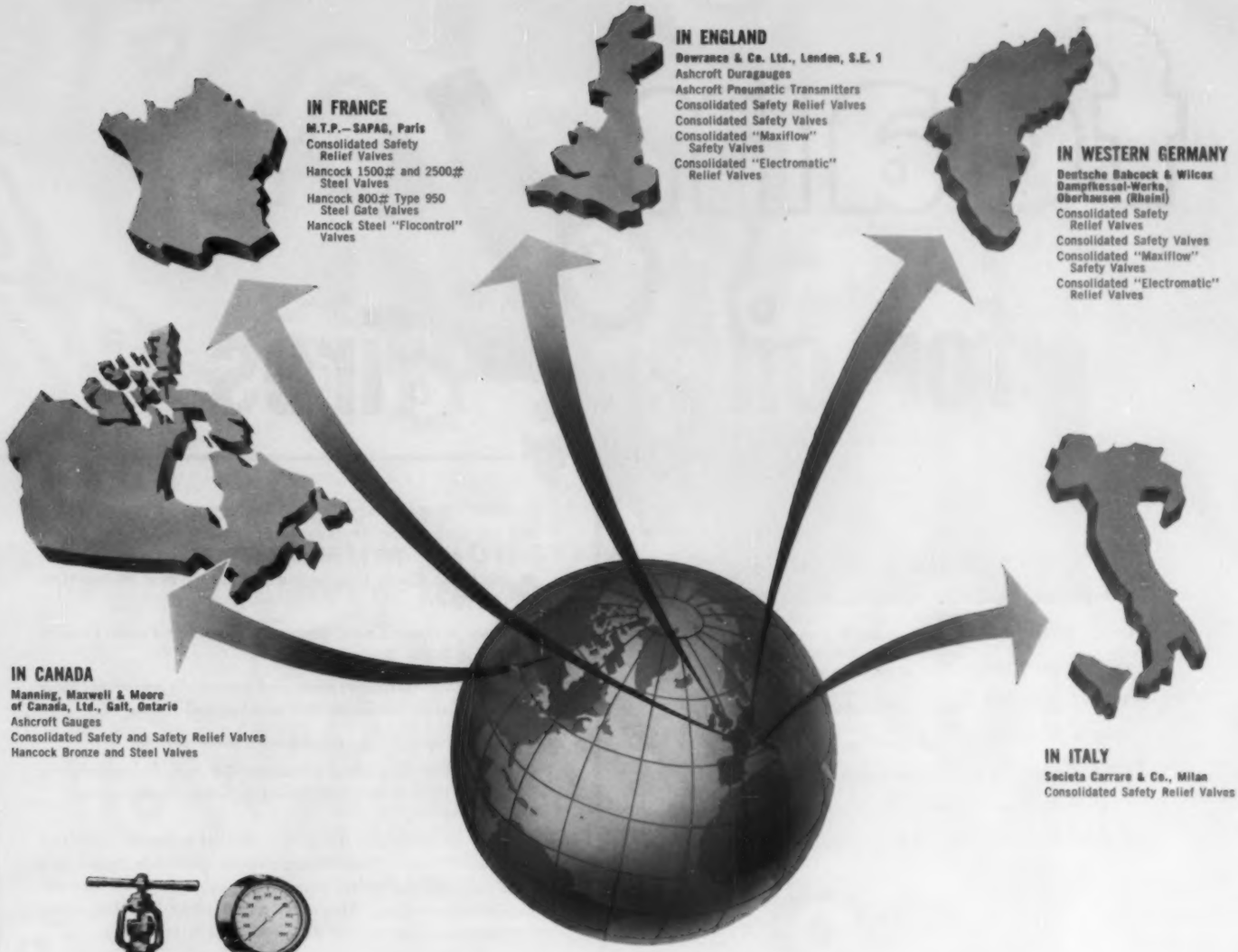
Attorney Brownell also put on a stand-by basis the Tanker Requirements Committee. He ruled that no meetings of the committee be held until the Maritime Administration finds "a national emergency" in the "tanker capacity" field. Future meetings will be called by the Maritime Administrator who will set the agenda and furnish minutes of the meeting to the Attorney General.

Government Agencies Appointments

Secretary of the Interior McKay has announced the appointment of 102 petroleum industry leaders to serve on the National Petroleum Council during 1956. Included were many of the heads of principal petroleum companies in the United States.

In his letter to the appointees, Secretary McKay stated that "the effective working relationship between the Federal Government and the petroleum industry maintained for over nine years is a magnificent tribute to the members of this Council who, in cooperation with many men and women in the petroleum industry, advance for use of government at its request advice, counsel, and information on the petroleum resources of our great Nation and matters concerned with the use of these resources."

The Secretary also announced that the term of the present membership of the Gas Industry Advisory Council has been extended to December 31, 1956. All the 61 members of the Council were therefore reappointed with the Secretary's comment that he believed that their advice and council should continue to be available to the Department of the Interior.



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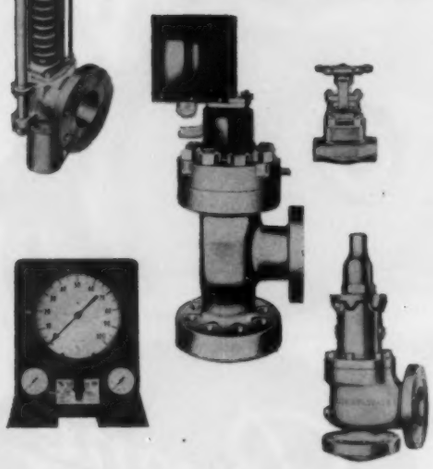

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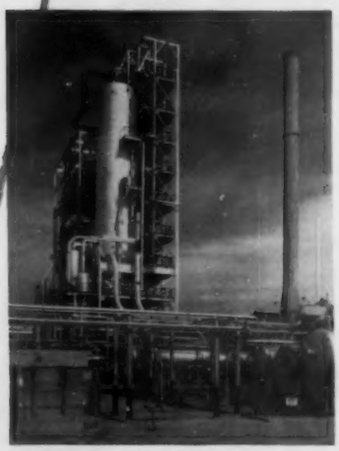

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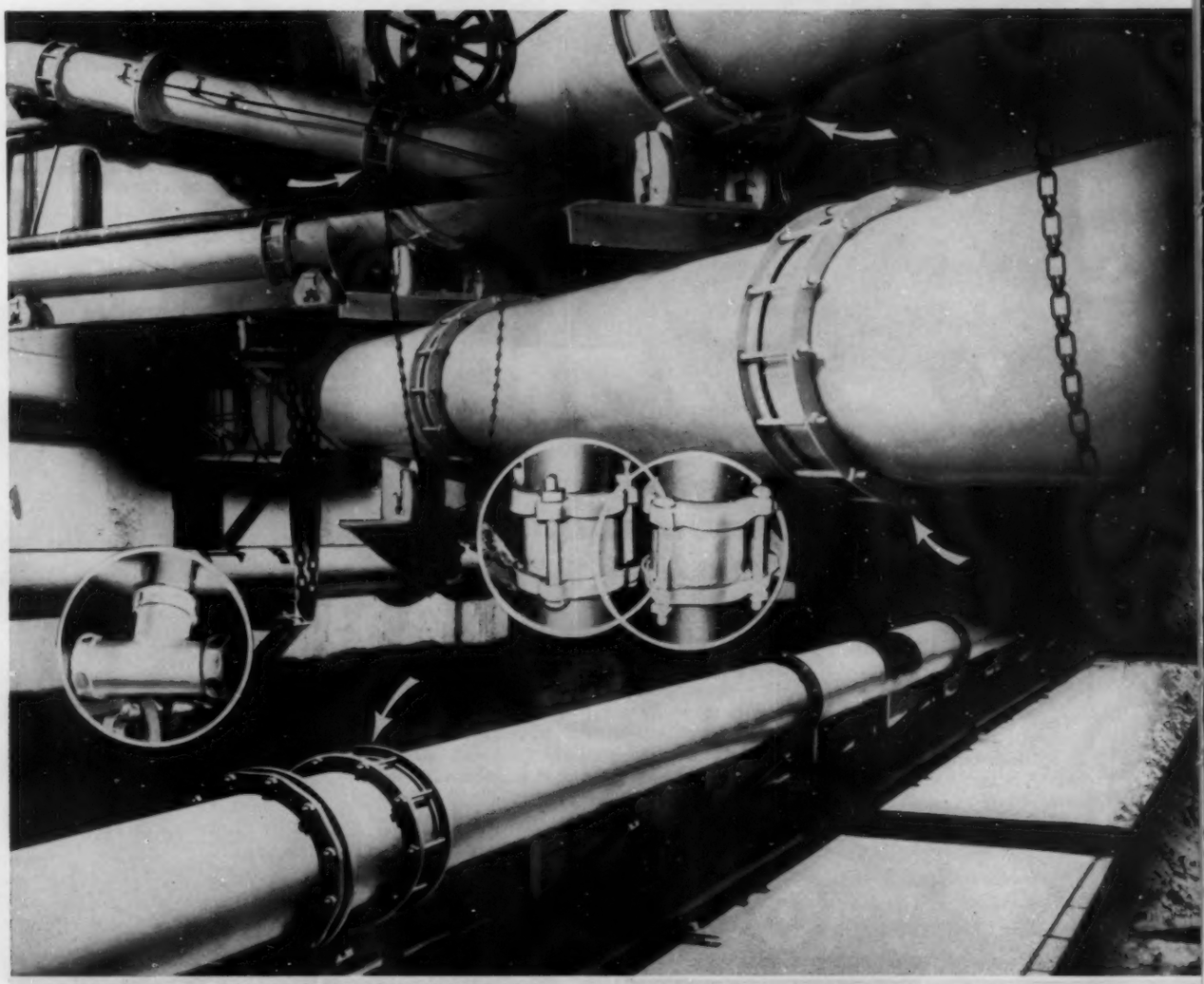

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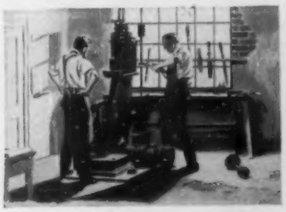
1909 Blue Ribbon Holder, H.M.S. Mauretania, held the North Atlantic speed record for 22 years. Like every Blue Ribbon winner since, she was protected by the *makers of Mobiloil!*



The first Diesel engine was developed in Germany in 1897. Rudolph Diesel, the inventor, solved his lubrication problem with special oils developed by the *makers of Mobiloil!*

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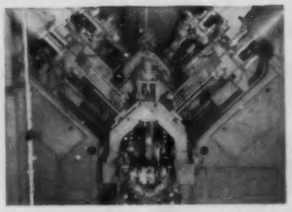
1955 Indianapolis Winner, Bob Sweikert, averaged a sensational 128.209 mph to win this 500-mile classic. He relied on *Mobiloil*—first choice of more drivers than any other brand.

World's First Atomic Powered Submarine, the "Nautilus," is dramatic evidence of a new age. Socony Mobil supplied the Gargoyle Marine Oils that helped in the development and operation of this undersea marvel.



Modern industry's new trend—manufacture through automation—depends on precise hydraulic control. Majority of automated plants call on Socony Mobil's 89 years' experience.

SOCONY MOBIL OIL COMPANY, INC.

and Affiliates: MAGNOLIA PETROLEUM COMPANY, GENERAL PETROLEUM CORPORATION

Makers of

Mobiloil—World's Largest-Selling Motor Oil | **Mobiloil Special**—America's Most Popular Year-'round Motor Oil

WATSON-STILLMAN FORGED STEEL FITTINGS FOR: *Safe, Tight Connections* in pressure piping

■ In high pressure steam lines... process liquid and gas piping... hydraulic fluid lines... wherever strong, tough pipe joints are needed, Watson Stillman Forged Steel Fittings provide a safety factor against costly piping failures. They resist pressure, heat, corrosion, shock and vibration because they're drop-forged of high quality steel to produce a dense, tough, forged-fiber structure that can really take it.

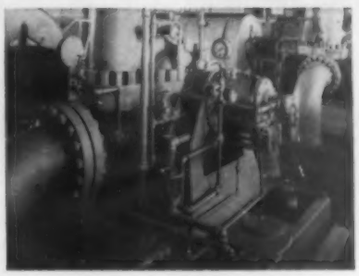
Extra strength is built into W-S fittings in other ways too... such as the heavy reinforcing bands extending well beyond the threads or sockets.

Protect your high pressure piping system with Watson-Stillman Forged Steel Fittings. Available in carbon, stainless and alloy steels, in Screw-End and Socket-Welding Types to meet your service requirements. Send today for Free Catalogs.

Bulletin A3-50—Forged Steel Fittings
Bulletin S-1-55—Stainless and Alloy Fittings
Bulletin U-1—Forged Steel Unions
Bulletin S-3-55—150 lb. Stainless Fittings

Sold Through Leading Distributors

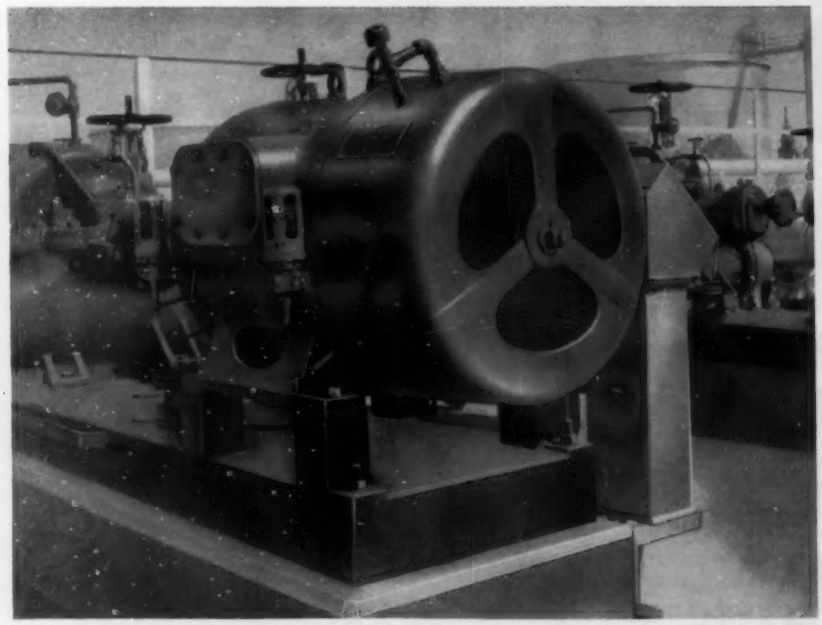
• *Process Liquid and Gas Piping*



• *High Pressure Lines*

W-S FITTINGS DIVISION
H. K. PORTER COMPANY, INC.
Roselle, New Jersey

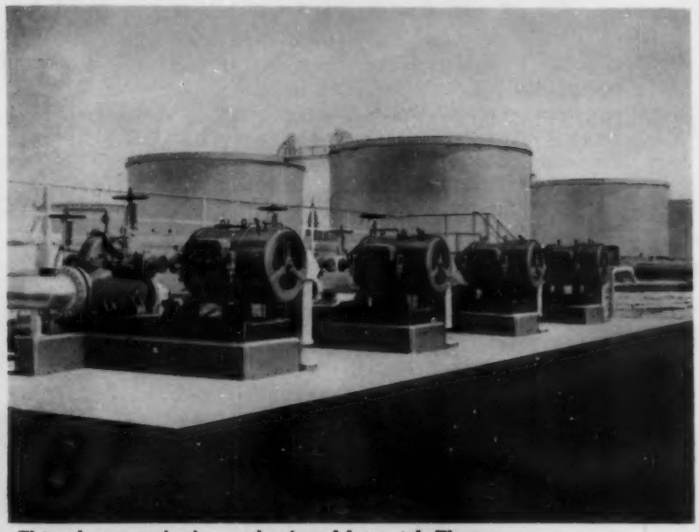
Flameproof Motors for the Oil Industry



A Metrovick 250 h. p. 1480 r. p. m. Flameproof Squirrel Cage Motor—one of four supplied to the Kwinana Oil Refinery.

Oil wells and refineries throughout the world rely on M-V equipment. Metrovick experience of motors and their proper application covers all drives in the oil industry, from drilling to refining. Some of the refineries using Metrovick motors are the Grangemouth Petroleum Refinery, Ltd., Shell Stanlow Refinery, Esso Refinery, Fawley, Trinidad Leaseholds Point-a-Pierre Refinery, B. W. I., and (illustrated) British Petroleum Company's Refinery at Kwinana, Australia.

Special arrangements were put in hand to guarantee that these motors were delivered to meet site requirements.



This photograph shows the four Metrovick Flameproof Motors driving kerosene pumps at Tank Farm Pumping Station No. 3. These motors are fitted with constant-level oil lubricators.

METROPOLITAN-VICKERS
ELECTRICAL CO LTD · TRAFFORD PARK · MANCHESTER, 17

Member of the A. E. I. group of companies

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If you use...or plan to use

HIGH-ALUMINA
CRACKING CATALYST

Specify

Nalcat HA-1 or HA-2

Continuous quality control and research progress are the products of Nalco Catalyst Division Laboratories.

Nalcat® *Nalform*

Production and Service to Match Petroleum Industry Progress

● If you are exploring the possibilities of high-alumina catalyst for your cracking operations, check on Nalcat HA-1 and HA-2 for research and production use. These high-alumina formulas are available in whatever quantities you require, promptly . . . as a part of the Nalco policy of *Service* to the Petroleum Industry.

CATALYST DIVISION
NATIONAL ALUMINATE CORPORATION
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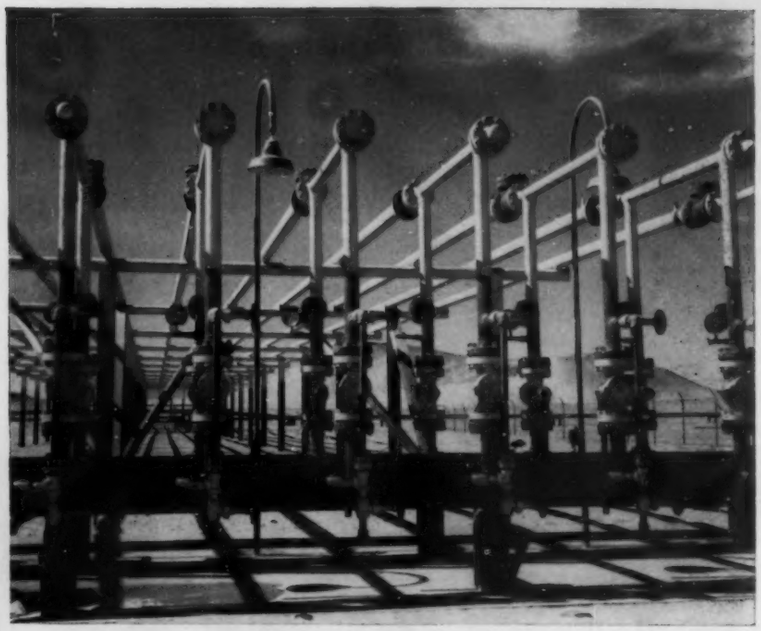
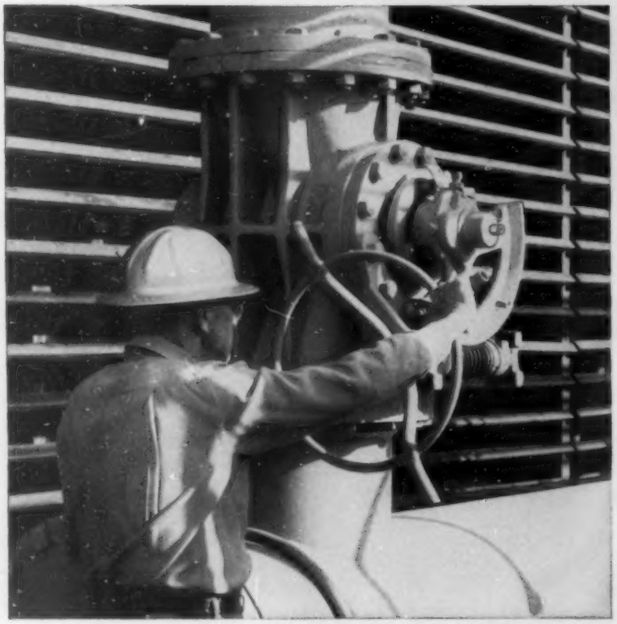
Out in the production fields...





...or in the heart of a refinery

NORDSTROM and AUDCO VALVES

Perform Better, Longer, For Less Money

For many years, Nordstrom and Audco *lubricant sealed* valves have proven that they shut-off tighter, operate more dependably and cost less to use than any other valve. That's why you'll see Nordstrom and Audco valves in remote desert production units or round-the-clock processing operations . . . or anywhere in the world petroleum is produced, transported, processed or marketed.

Nordstrom and Audco lubricated plug valves come in the *only* complete range of sizes and pressure ratings to answer every petroleum flow control need. Why not standardize on Nordstrom and Audco valves for *proven* economy and enduring performance? Write for more information.

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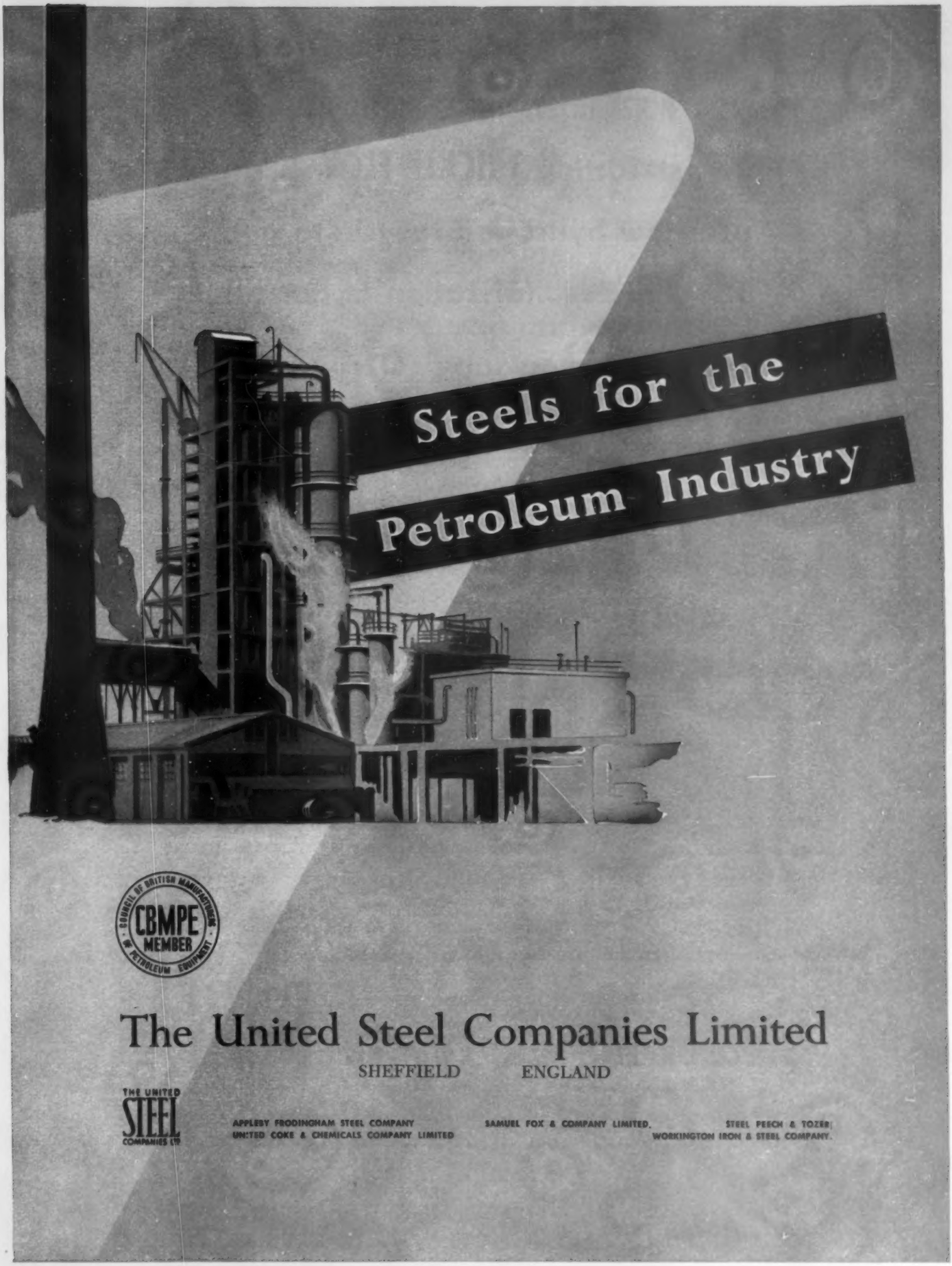
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New cost-cutting TRICKLE FLOW process uses low hydrogen recycle to get 99.5% desulfurization of gas oil

With 80% hydrogen purity, the new SHELL TRICKLE FLOW process yields doctor-sweet product at lower cost.

TRICKLE FLOW operation offers you these five additional advantages:

1. **Smaller, simpler, easier-to-maintain plant**
2. **No need to rerun product**
3. **High liquid yields**
4. **Sustained catalyst activity**
5. **Uses a rugged, low-cost catalyst**

Flexible TRICKLE FLOW process has been refinery-proved, and now is successfully turning out a premium product in the modern Canadian Petrofina Refinery. This unit was engineered by the Lummus Company.

We'll be glad to supply further information about this efficient, low-cost desulfurization process. Address your inquiry to:

SHELL DEVELOPMENT COMPANY
50 West 50th Street, New York 20, New York

SHELL

DU PONT

PETROLEUM CHEMICALS DIVISION

NEWS

DU PONT

April ★ One of a Series of Interest to the Petroleum Industry ★ 1956

Question Box

1. HOW MANY of your products can be protected against copper contamination?
   Count them in the article at right.
2. ARE YOU considering a new automatic component blending setup?
   If so, you will want to look into the service offered below.
3. WHO heads up the Du Pont Petroleum Laboratory?
   You'll "meet" him when you turn the page.
4. HOW CAN you be sure the heating oil you put into storage now will still be stable next winter?
   The information on the next page may help you make sure.

CONTINUOUS BLENDING OF GASOLINE COMPONENTS AND ADDITIVES

What advantages and dollar savings does it offer YOU?

If you are not already using partial or continuous on-stream blending, you may be considering the possibilities of setting up such an operation.

Users report that dollar savings which can be realized through these automatic methods may be substantial. And in today's highly competitive market, no one can afford to overlook any opportunity for cost reduction.

In many cases, facilities used in batch operations can be converted to partial on-stream blending by the addition of a relatively few pieces of equipment – such as pumps and recorder-controllers. A somewhat larger investment is generally required to set up equipment for continuous, automatic on-stream blending.

Before you take the step from batch to continuous blending, you may want to talk over the potentials and problems involved with an impartial consultant. Mr. B. G. Crane, Du Pont Petroleum Chemicals Division operations manager, will be glad to discuss it with you. During many years of work on all phases of additives blending, he has had the opportunity to observe the evolutionary development of continuous on-stream blending in numerous refineries. Because of this broad experience, his advice and help may be valuable to you.

For more detailed information on automatic blending procedures and how to select the type most practical for your own operations, you can get in touch with Mr. Crane at our Wilmington office, or call any of our sales offices listed on the next page.

Du Pont Metal Deactivator can improve MANY of your petroleum products

Du Pont technical services can help increase its value and usefulness to you

You have probably used a metal deactivator in your gasolines for some time . . . and are quite familiar with its effectiveness and advantages. But you may not be aware of the broad applications of Du Pont Metal Deactivator and its benefits which can be applied to many of the other petroleum products you make.

THE APPROVAL of metal deactivator for use in military aviation jet fuels further points up the versatility and broad usefulness of this Du Pont additive.

The list of the products which can be improved with Du Pont Metal Deactivator (DMD) includes diesel fuels, home heating oils, kerosines, jet fuels, turbine oils, greases and gasolines.

Technical services

To help you take advantage of the benefits of metal deactivator in all these products, Du Pont offers comprehensive technical services that are geared to your own individual needs and manufacturing operations. These services, which are coordinated through the Du Pont Petroleum Chemicals Division's five regional laboratories, can often help you put your whole additives program on a more economical basis. For example . . .

Because combinations of DMD with other Du Pont additives often work more efficiently than one additive alone, the Du Pont laboratory recom-

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

OVER

DU PONT

PETROLEUM CHEMICALS DIVISION NEWS

DU PONT

CONTINUED *Metal Deactivator*

mendations can help you achieve your desired stability with less additive . . . often at a substantially lower treating cost.

For fuel oils

In diesel fuels and home heating oils, DMD helps prevent color deterioration and the formation of gelatinous sludge due to copper pickup from feed lines and fittings. And in many cases, it not only improves the storage stability of fuel oils, but also increases the effectiveness of other stabilizing additives used in conjunction with it.

In jet fuels

DMD has been approved by military specification (MIL-F-5624C) for use in jet fuels to inhibit deterioration, thereby decreasing fuel system plugging and residue formation.

Kerosines

In kerosines, DMD is useful as a color stabilizer in some copper-sweetened stocks. It has also been reported effective in reducing carbon and coke formation in pot burners by as much as 50%.

For greases, too

Since many greases, especially bearing greases, are likely to come in contact with metals containing copper alloys, adequate protection against copper contamination is vitally important. For maximum effectiveness in this application, DMD is frequently combined with a Du Pont grease antioxidant.

Are you realizing the benefits of using metal deactivator in all these products? If not, it will certainly pay you to discuss its use with a Du Pont Petroleum Chemicals Division representative. Or you can ask one of our conveniently located regional laboratories to test its effectiveness in your own stocks.

Because combinations of DMD with other Du Pont additives so often bring still additional benefits, our people are especially well-qualified to help you get the best results at the lowest possible cost. Just address your request to any of the sales offices listed below.

HEADS DU PONT PETROLEUM LABORATORY

DR. BERNARD M. STURGIS is director of the Du Pont Petroleum Laboratory, heading up all technical and customer service activities of the Petroleum Chemicals Division.

A native of Indiana he graduated with an A.B. degree from De Pauw University. Three years later he received his Ph.D. degree in organic chemistry from the Massachusetts Institute of Technology.

Then, in 1936, he joined the Du Pont Company as a research chemist at the Jackson Laboratory. In 1951 he was transferred to the Petroleum Laboratory as head of the combustion and scavenging division. He later became assistant director and finally director of the laboratory.

For his paper, "Some Concepts of Knock and Antiknock Action," he recently received the Horning Memorial Award in January 1956. This is the third time the Horning Award has been presented to a scientist from the Du Pont Petroleum Laboratory. It was previously awarded successively to Daniel L. Pastell and Leon F. Dumont for their work on precombustion reactions and combustion chamber deposits.

Dr. Sturgis is active in many technical societies and organizations, including the Combustion Institute, the American Chemical Society, the Society of Automotive Engineers, the American Petroleum Institute, and the Coordinating Research Council.

"Preventive medicine" now can reduce next winter's heating oil headaches

The chances are that you have started to put into storage your next winter's supply of home heating oil. But will it come out of storage as stable as it goes in?

You can be assured of the right answer to this question *now* . . . by adding Du Pont Fuel Oil Additive No. 2 (FOA-2) to your freshly prepared stocks at the refinery, before they go into storage.

Stabilizer and sludge dispersant—Filter clogging can be greatly reduced by the addition of FOA-2 because it not only stabilizes the fuel but also disperses any sludge that may already be formed — by reducing the size of the sludge particles.

Ashless — Many of your distributors' service calls may be caused by electrical failures due to a metallic ash coating on the electrodes and stack controls. Because it is ashless, Du Pont FOA-2 can help eliminate these wasteful service calls, too.

Avoid gel-clogged lines—By adding a small amount of Du Pont Metal Deactivator, you can also protect fuel from becoming contaminated by copper which is often used in heating system fuel lines. This will, in most cases, eliminate any danger of the lines becoming clogged by a gelatinous material due to copper pickup.

Ask us for samples.

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Better Things for Better Living
. . . through Chemistry

Petroleum Chemicals

E. I. DU PONT DE NEMOURS & COMPANY (INC.) *Petroleum Chemicals Division • Wilmington 98, Delaware*

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A-1341

Printed in U. S. A.

"Exploration for and development of new crude reserves have proceeded vigorously. New refining and transportation facilities have been built in many parts of the world. New organizations have entered the industry and are striving for a substantial share of the market, while longer established companies are making strong efforts to hold and increase their market positions. Rivalry has spurred still greater research activity and has led to further advances in petroleum technology. The ultimate beneficiary of all this competition is the consumer."

— Eugene Holman, Chairman of the Board, Standard Oil Company (New Jersey)

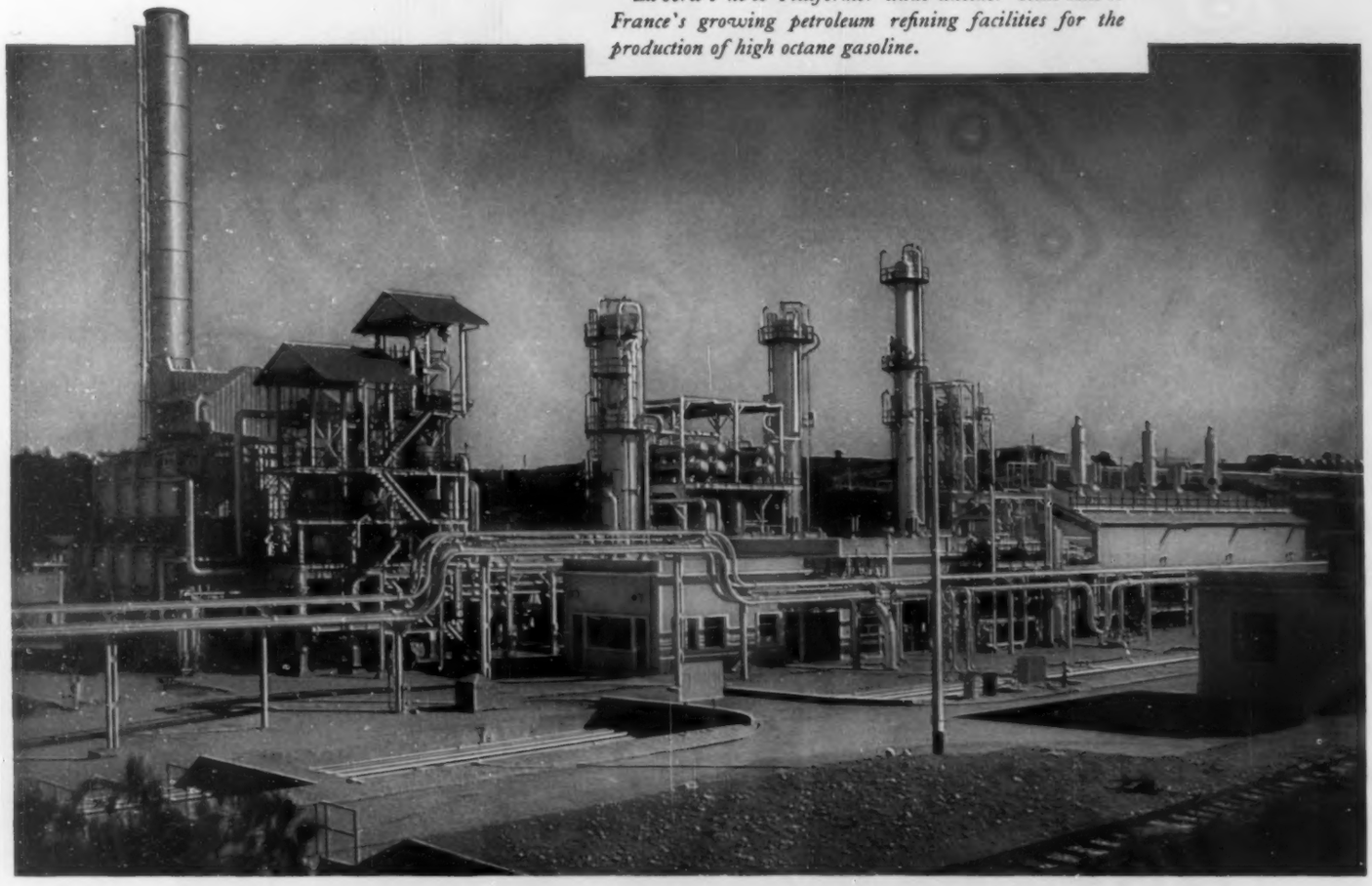
ESSO

STANDARD OIL COMPANY (NEW JERSEY)

AND AFFILIATED COMPANIES

The Latest at LAVERA...

Lavera's new Platformer adds another vital unit to France's growing petroleum refining facilities for the production of high octane gasoline.



At the Lavera Refinery of Société Française des Pétroles BP, near Marseilles, France, a 6000 BPSD catalytic reforming unit has recently been completed.

In the design and construction of this modern processing unit the engineering knowledge and methods of three great nationalities were coordinated and combined for the progress and expansion of free world enterprise. The unit embodies the latest United States design techniques, adapted to French standards by English and French engineers. It incorporates materials and equipment largely of French manufacture and was constructed by French mechanics.

Stone & Webster Engineering Corporation, in cooperation with its British and French affiliates, provided the necessary engineering, procurement and supervisory construction services.

This and the similar units erected at Kent Oil Refinery Ltd. and National Oil Refineries Ltd. for The British Petroleum Company Ltd., in the United Kingdom illustrate the international scope of integrated assistance available to refiners throughout the free countries of the world by the Engineering Corporation and its affiliates.

Write or call us for information as to how our experience may be of assistance to you.

STONE & WEBSTER ENGINEERING CORPORATION

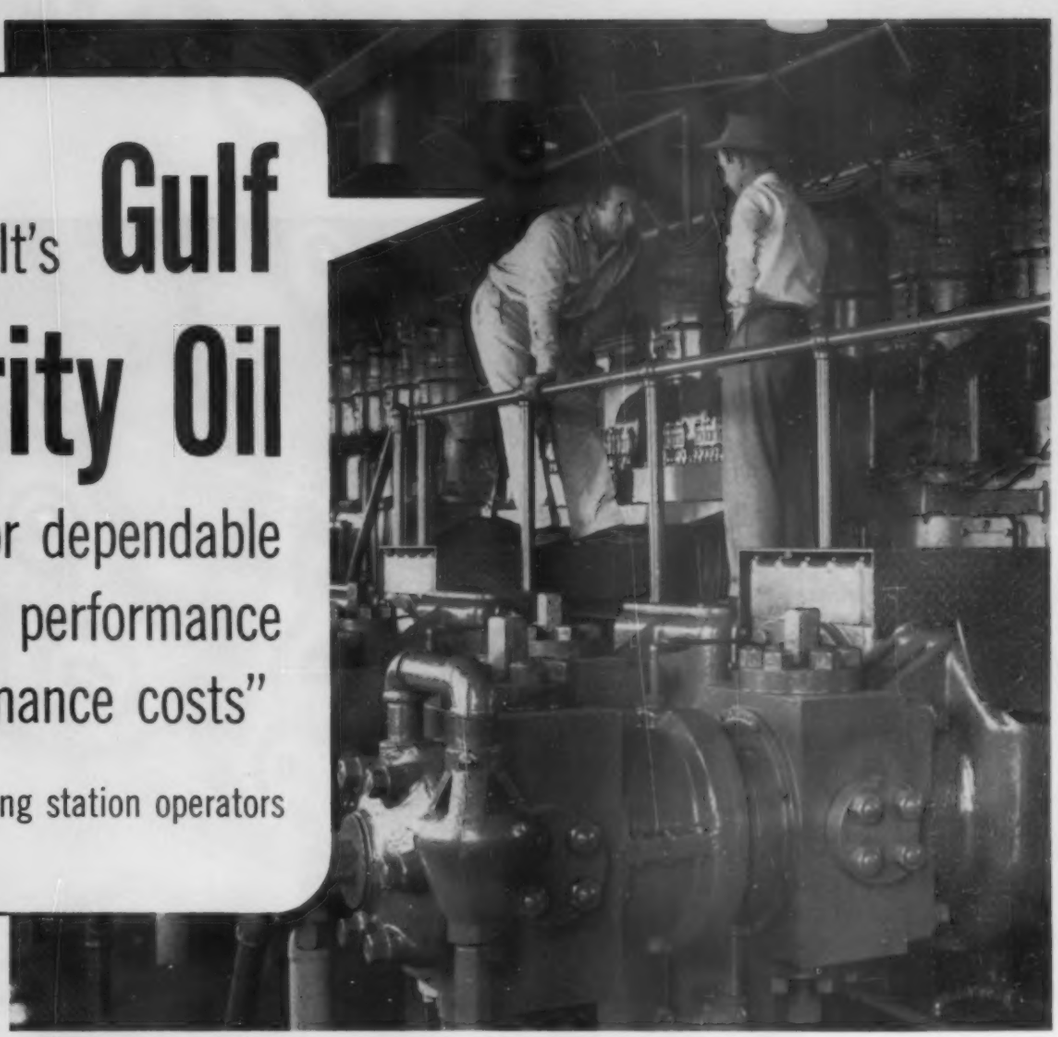
BADGER PROCESS DIVISION

AFFILIATED WITH E. B. BADGER & SONS LIMITED (LONDON)

New York Boston Chicago Pittsburgh Houston San Francisco Los Angeles Seattle Toronto

"It's Gulf Security Oil for dependable gas compressor performance and low maintenance costs"

say pumping station operators



Smooth, continuous operation is a must for these units in service at a South Texas gas compressor plant. They are responsible for the steady flow of essential natural gas through pipe lines to homes and industries as far north as Detroit and New York. Gulf Security Oil provides the sure, effective protection needed for cylinders and bearings in both engines and compressors.

You can depend on Gulf Security Oil to provide the proper lubrication that is so important to vital compressor units if operating troubles are to be prevented and maintenance costs kept low.

Gulf Security Oil has a record of outstanding performance in scores of gas transmission plants. After years of operation with this quality oil, the cylinders and piston rings of both the compressors and power assemblies show negligible wear. And few carbon deposits have formed on power cylinder ports and pistons.

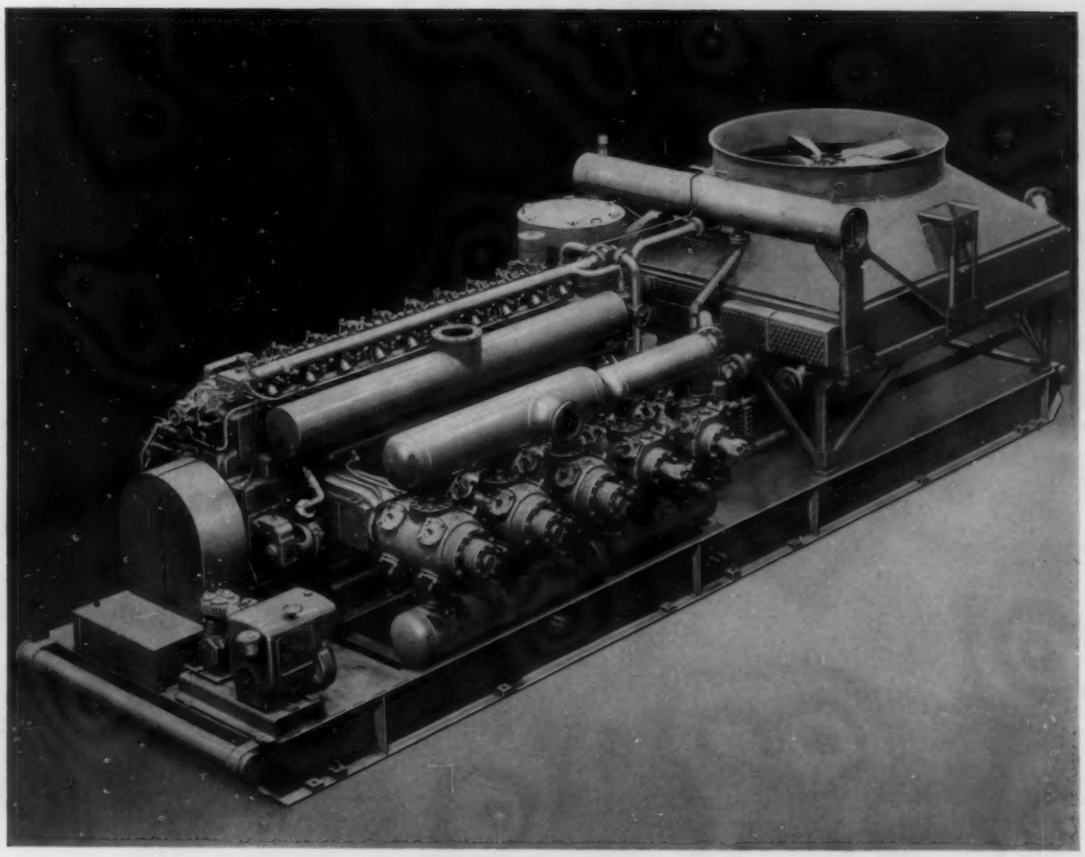
If you are installing new compressor units, or feel that you're not getting the most effective lubrication possible for your present units, it will certainly pay you to try Gulf Security Oil. Contact your nearest Gulf Office and have a Gulf Sales Engineer call.

Gulf Oil Corporation • Gulf Refining Company

1822 GULF BUILDING, PITTSBURGH 30, PENNSYLVANIA

GULF

The finest petroleum products for your every need



The Clark model HMAB is a completely self-contained compressor station. It is built in ten, eight and six cylinder sizes of 550, 440 and 330 BHP respectively.

Packaged Field Compressor Introduced by Clark

New "Midget Angle" develops 25% more power

A 25% more powerful "packaged" compressor station for field use has been introduced by Clark Bros. Co., Olean, N. Y.

According to Clark Engineers, the new Midget Angle is a huskier, heavier built unit in all respects than its famed predecessor.

The increased power is developed as the result of greater displacement and a redesign of the combustion chamber and power cylinder porting.

Retains Balanced/Opposed Principal

The new model HMAB incorporates the patented Balanced/Opposed principal of the original Midget Angle. This design results in vibration-free operation. Installation can be readily made on piles, barges, trailers or poor load-bearing soil without costly preparation.

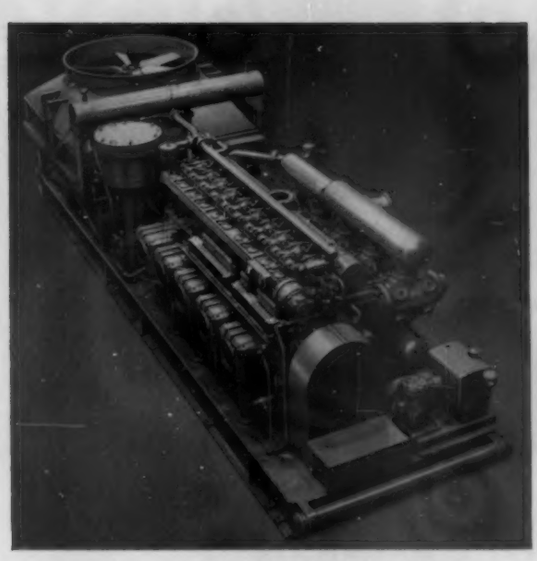
Heavy Compressor Design

The bore and stroke of the new unit has been increased to 8⅜ x 8⅞ inches. To handle the increased power output—power pistons, power cylinder liners, heads, connecting rods and crossheads have been increased in size. Both the upper and lower crankcases have also been increased in size and weight to handle additional horsepower.

To promote accessibility, the lube oil pump has been mounted on the end of the crankcase—opposite the flywheel end. The water pump is also mounted on the crankcase and is chain driven from the crankshaft. A fully insulated exhaust manifold is used, saving 25% in water cooling load per BHP.

Radiator Designed for Rugged Field Service

The HMAB features an induced vertical air flow radiator design. Wind direction can be disregarded. An exceptionally even flow of air over the entire cooling surface results from the induction principal. Cooling surface is also spread over a large area to permit a close approach to ambient temperature. The finned tubes of each section terminate in common mani-



The packaged unit can be shipped by railroad as a complete unit eliminating costly field assembly.

The extra deep skid or base for the unit is built up from 18" and 20" I beams.

folds, thereby eliminating the need for return bends. Plugs in the manifolds, in line with each tube, permit straight-through visual inspection of the tube inner surface. Tube cleaning, if ever necessary, can be accomplished without removal from the radiator. A unique feature of the Clark radiator is the use of a hydraulic motor to drive the fan. Complicated and often troublesome belt drives are eliminated. Fluid power for the hydraulic motor is furnished by a flywheel driven oil pump. Railroad shipment is possible without removing the radiator from the skid.

Massive Steel Skid

An extra heavy box type skid that is highly resistant to bending or twisting is provided for the packaged units. Main members are 20" I beams. Cross members are 18" I beams and are continuous to assure maximum rigidity. Accessory equipment such as the starting air compressor, interstage scrubbers, air cleaner, surge tank, etc., are engineered into the packaged design. The Clark Midget Angle eliminates costly field erection. Connect fuel and supply lines and it is ready to operate.

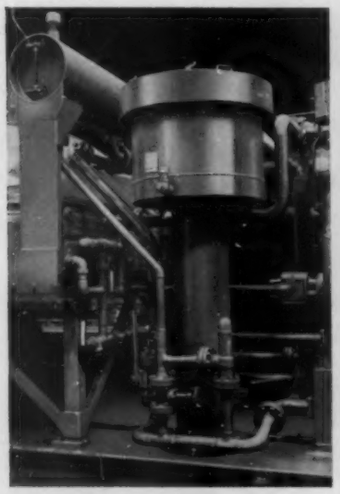
Factory Tested Packages

Every HMAB is completely assembled and tested as a unit. With Clark there is never divided responsibility.

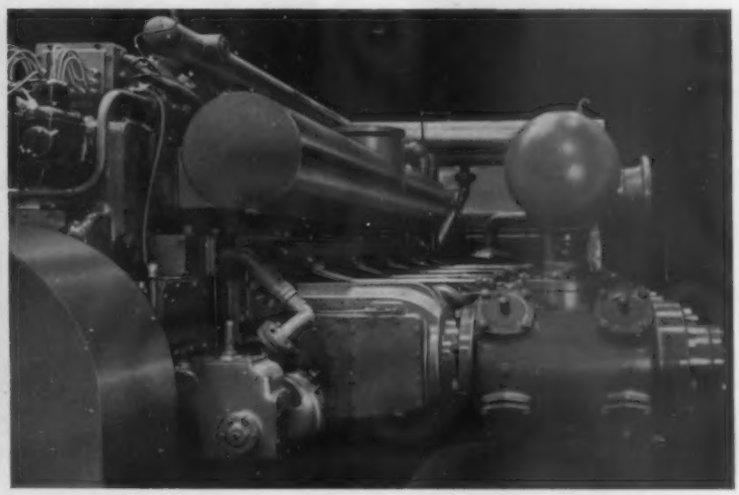
Built in Three Sizes

The HMAB will be built in ten, eight and six cylinder models of 550, 440 and 330 BHP respectively. Additional information on the HMAB as well as on the smaller HMA which will continue to be built, is available at any Clark office.

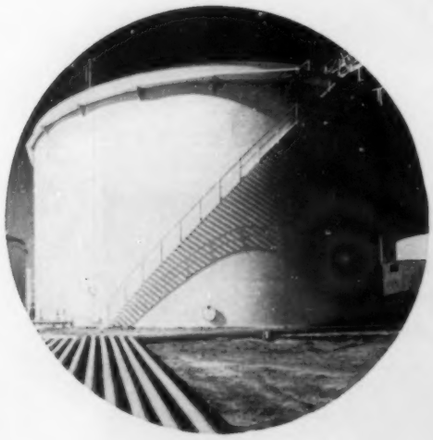
CLARK BROS. CO., Olean, N. Y.
One of the Dresser Industries

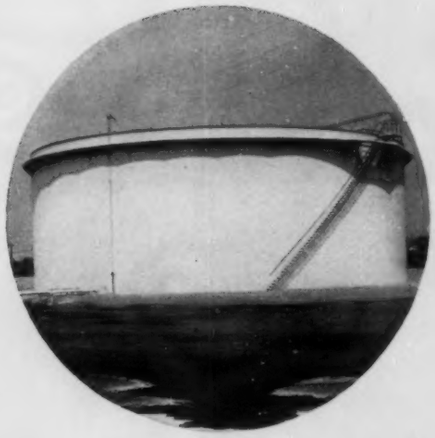


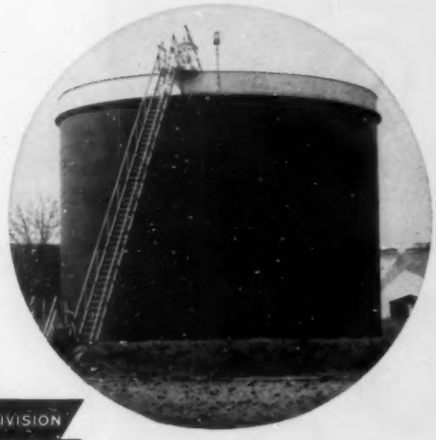
The HMAB has an external oil pump. Air cleaner, scrubbers, etc., are mounted between the compressor and radiator.



Use of a fully insulated exhaust manifold in place of a water cooled manifold saves 25% in cooling duty per BHP. An external chain driven water pump is provided.







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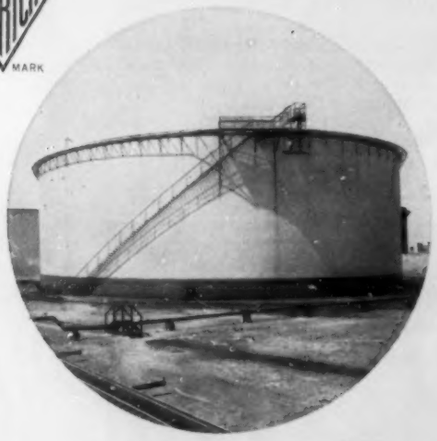
DEPENDABLE IN USE!
USED ALL OVER THE WORLD

EXPORT DIVISION
GENERAL AMERICAN
TRADE MARK



wiggins floating roofs

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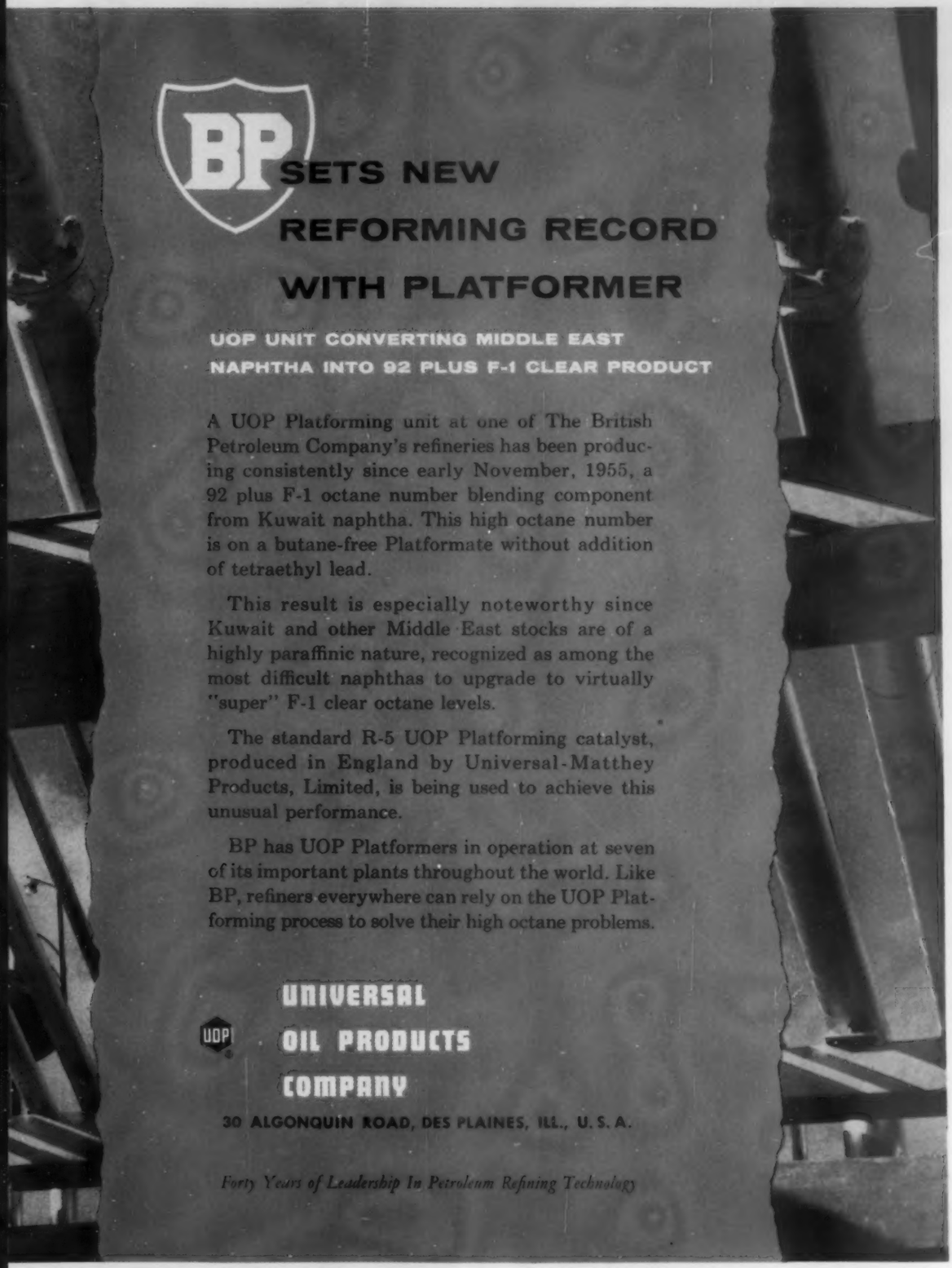
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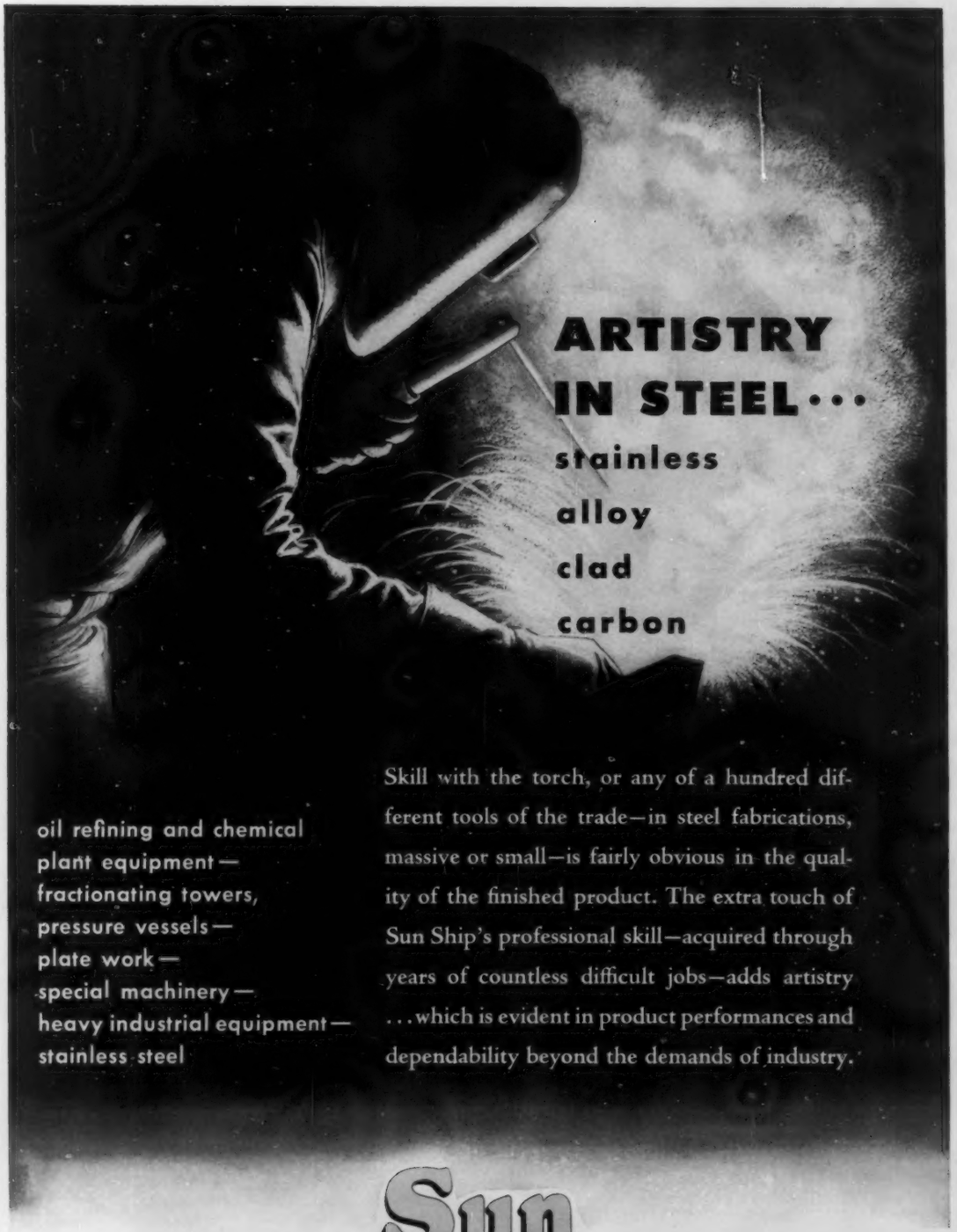
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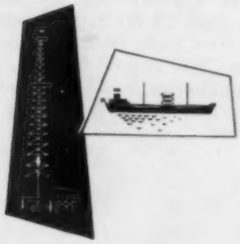

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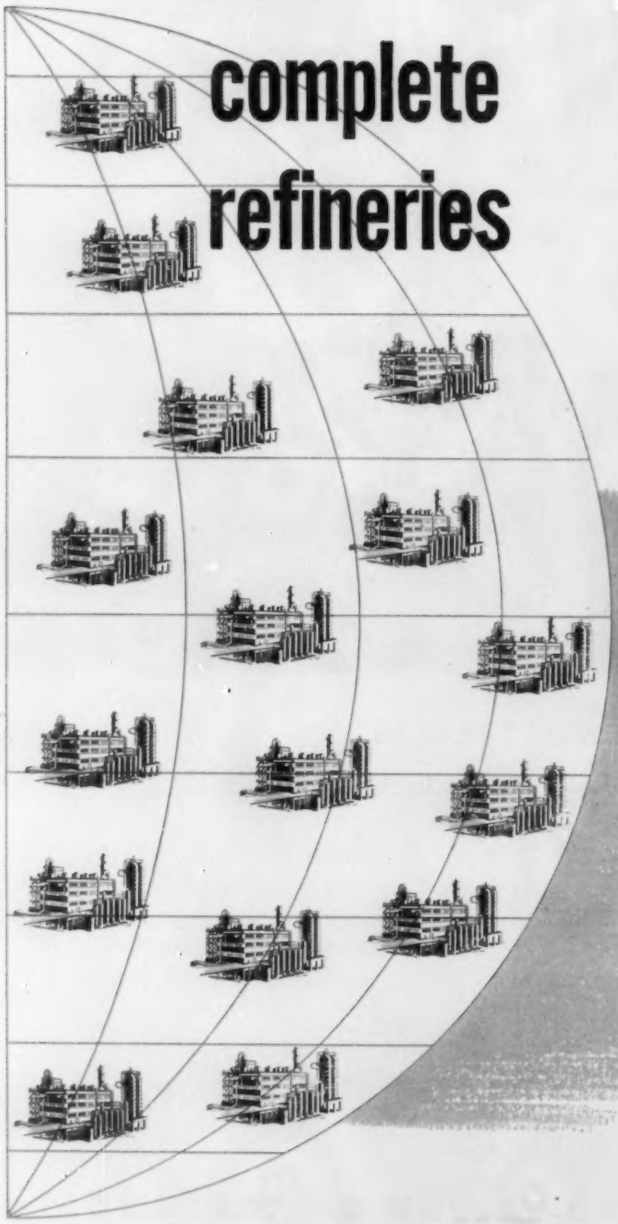

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Member of National Business Publications, Inc., and Business Publications Audit of Circulation, Inc.

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Annual subscription $5.00
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Single copies $1.00

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World Petroleum is published by Mona Palmer, Trustee under the will of Russell Palmer.

VOL. 27, NO. 4 APRIL, 1956

World Petroleum

THE MANAGEMENT PUBLICATION OF THE INTERNATIONAL PETROLEUM INDUSTRY

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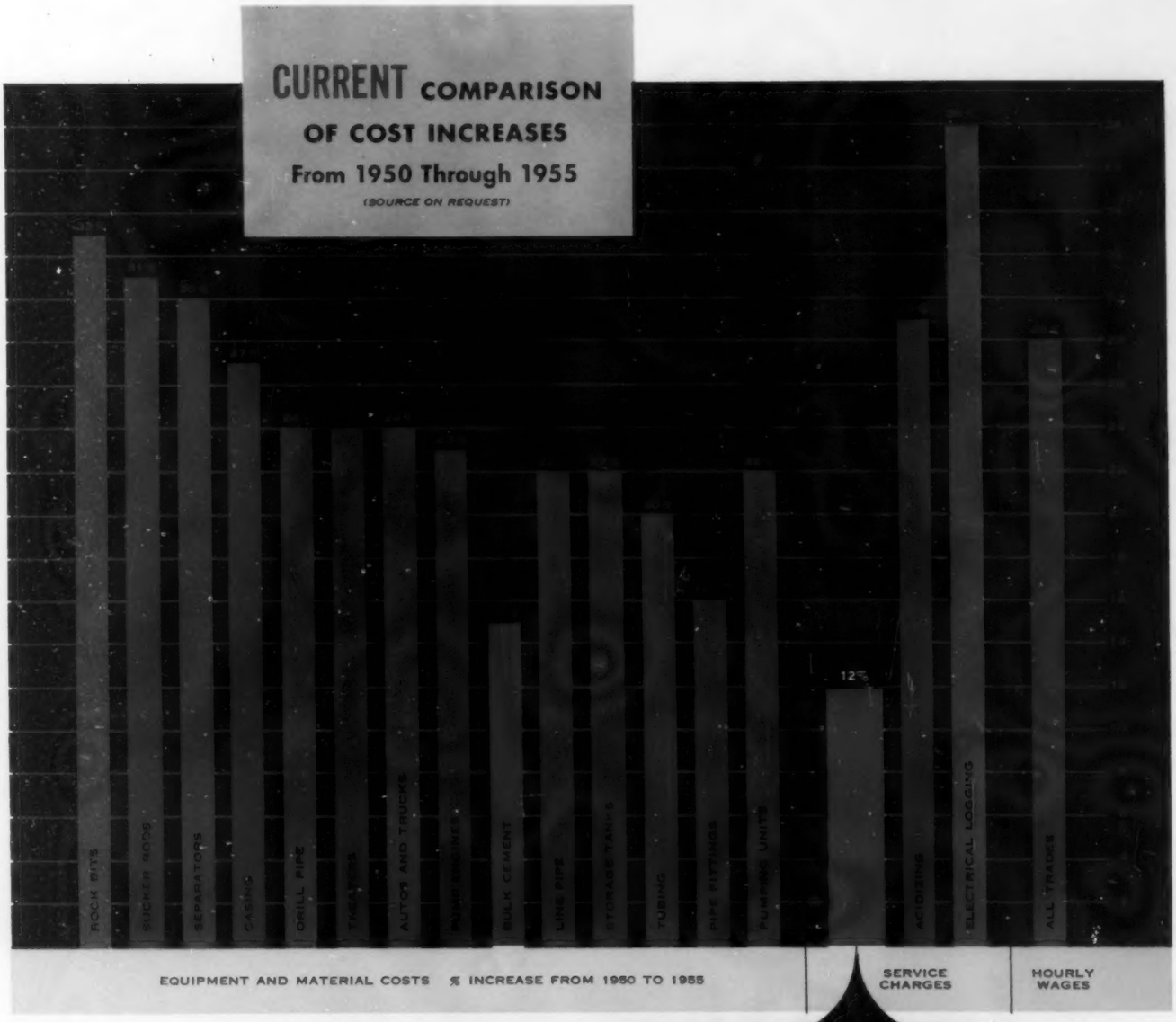
THIS MONTH'S COVER

Cleaning out a well preparatory to production. Photograph by El Paso Natural Gas Co. Color plates are reproduced here through the courtesy of the editors of *Steelways*, published by the American Iron and Steel Institute.



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Can The Industry Defend Itself?

OUTCOME of the long struggle over the natural gas bill leaves one lasting impression on the minds of thoughtful citizens of the United States. That is the sensation of complete futility with the outcome of the whole procedure. Were it not for its ultimate effects upon the petroleum industry and indeed up the whole economy, the extent of which remains quite immeasurable at present, the whole affair might be regarded as a huge comedy of errors, in which consideration of matters of national importance are diverted to unrelated details.

The case of the wrecked gas bill illustrates this point exactly. From the time, nearly two years ago, when the Supreme Court handed down a decision conferring upon the Federal Power Commission authority to fix the price paid to intrastate producers of natural gas delivered to carriers for interstate transportation, the subject has been one of active discussion and argument.

To members of the petroleum industry and to believers in the system of free enterprise the decision of the Court raised an issue of fundamental importance in that it opened the door to federal regulation of prices in purely local transactions which might in time be extended to all fields of industry and completely revolutionize our traditional economic system.

For precisely the same reasons that inspired this opposition the advocates of centralized control over business and industry supported the Court's action as a move in the direction they want the nation to travel.

Nobody connected with the oil industry needs to be reminded of the history of Congressional attempts to deal with the subject from the adoption by the House of Representatives of the Harris-Fulbright bill, which would have preserved the traditional policy of open competition as the determinant of prices and would have revoked the decision of the Court, through the prolonged debate within the Senate up to the time when Senator Case of South Dakota made public announcement of his rejection of a contribution to his campaign fund because of his suspicion of the motive behind the proffered gift.

This statement, containing elements of a possible scandal, shifted public attention from the real issue involved to the possible use of "oil money" in efforts to forward enactment of the proposed law which let loose a barrage of attacks upon the industry and demands for an investigation. All this did not stay the Senate from completing the task assigned to it which it proceeded to do by approving the Harris-Fulbright bill by a margin considerably greater than its supporters had expected while for the protection of its own members it set up a committee to inquire into possible use of improper means for forwarding the bill which later was enlarged to cover the whole field of attempts to influence legislation.

This is not the first time that the petroleum industry has had to suffer for the actions of individuals who were in no way representative of the general sentiment of the industry or from sweeping charges that had no real foundation in fact. In general the industry has let such attacks go unanswered, but beyond question they are capable of doing great harm by spreading suspicion and distrust sufficient to impair the good effect of the industry's constructive efforts to improve its service to the public and to add strength to the national economy. Situations like the present, revive suggestions that petroleum should have somewhere some agency capable of defining its position on public questions.

None of the numerous industry organizations, national, sectional or technical is in a position to undertake the task. Each has its definite field and each avoids involvement in controversial or political matters, but in critical situations the industry should have somebody to speak authoritatively for it.

Assuming, as presumably will happen, that the Senate committee now directed to study the whole subject of activities intended to influence legislation ultimately brings forward recommendations for stringent regulation of paid or voluntary spokesmen for interested parties and full publicity for other activities recognized as wholly legitimate, an agency representing the petroleum industry and located preferably in Washington could impress the necessity of conforming to the requirements laid down, could cooperate with governmental authorities in exposing and discouraging violations and, when occasion required, could state convincingly the objections to proposals likely to hamper its own freedom of operation and to be injurious to the national economy. These are all legitimate activities which command the approval of united sentiment within the industry itself and should help to correct damaging misunderstandings against which there is now no effective avenue of defense.

JAPAN

Having recovered from war difficulties, Japan has returned to its historic rate of expansion as a consumer of energy. Oil's share of the energy market has doubled in the past 20 years and is expected to continue this trend since domestic coal and hydroelectric energy supplies are nearing their economic limit.

Masaya Ishii, chief of the market research section of the sales department of Mitsubishi Oil Co., Tokyo, joined that company in 1935 following his graduation from the Tokyo Imperial University. His company is one of the largest refinery operators in Japan with a complete plant at Kawasaki having a throughput capacity of 29,000 barrels daily.

AN EXPANDING OIL MARKET

By Masaya Ishii

COAL and lignite today are supplying almost a half of the energy consumption in Japan. Hydroelectricity has gradually expanded and oil consumption has grown rapidly in recent years. Oil's share of Japan's energy consumption is much higher than the pre-war days, it has in fact doubled during the past 20 years. Proportional consumption of coal, lignite, charcoal and firewood have been greatly reduced although statistics covering the consumption of charcoal and firewood in the past years are believed much smaller than the actual consumption.

Japan's domestic demand for energy has grown far more rapidly than domestic energy supply. The gap between the possible supply and actual demand in the coming years must be filled by imported energy resources, chiefly by oil. Coal is the main indigenous energy resource in Japan. In 1955 coal production totaled about 42.5 million tons and hydroelectricity 45 billion kwh (equivalent to 35 million tons of coal). The Economic Planning Board estimated the total energy demand for 1955 at nearly 107 million tons of coal equivalent and to make the total supply meet the estimated demand, Japan imported 10 million kls (62.9 million barrels) of oil, most of which was required to cover the newly increased demand. According to the government's (Economic Planning Board) estimates, the total production of industry and mining will increase by 54% by 1960, but the maximum production of domestic coal is estimated at only 51 million tons and hydroelectricity at 58 billion kwh (equivalent to 45 million tons of coal) in 1960. This means that the two main domestic energy supplies can be increased only by 18 million tons of coal equivalent or 17% of 1955 energy demand in the five-year period, under consideration of 1955-60.

The planning board estimated that the energy demand in 1960 would be increased by only 24% because of the betterment of thermal efficiency. This is considered by most observers to be merely a rosy dream to balance the trade amount of import and export on the paper plan. Of course, engineering endeavor will effect higher thermal efficiency in the long run, but the percent of improved thermal efficiency shown in the data is mostly accomplished by the increased use of petroleum.

Before 1952, the ratio of petroleum to total energy consumption was the same or lower as in the pre-war days and production had been increased in the same ratio as consumed energy. During the three years since 1952, industrial production increased by 45%, while the energy consumption rose only by 20%. Then, how about the oil con-

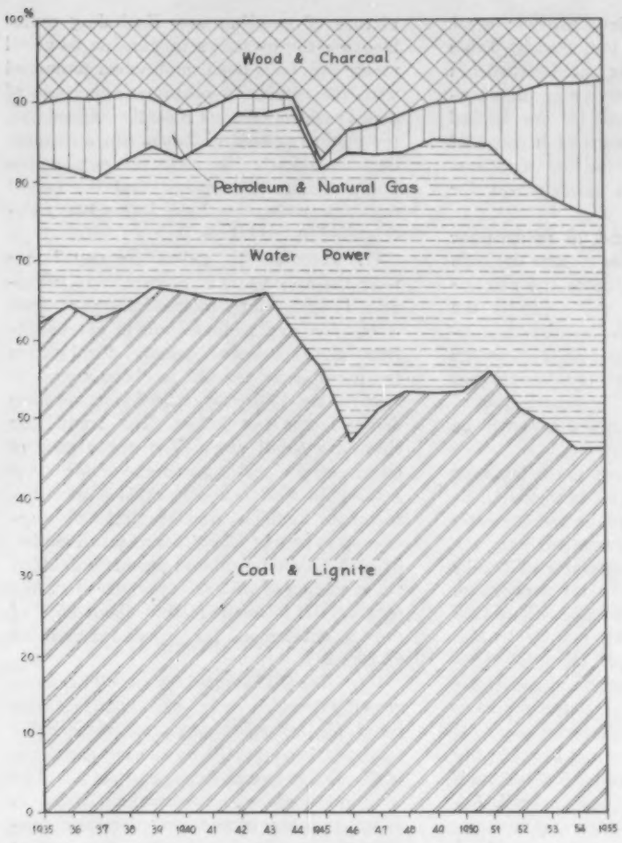


FIG. 1—*Energy consumption structure in Japan.*

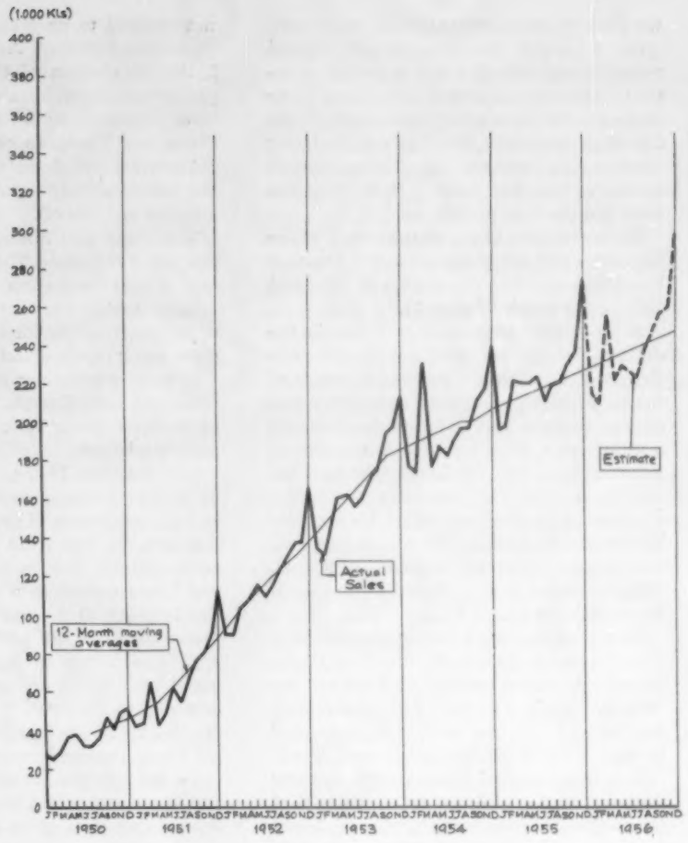


FIG. 2—*Trend of gasoline demand in Japan.*

sumption? It increased by 180% during the three years. If the energy structure is to remain unchanged, how can thermal efficiency be improved within the limited energy supply? If the aim is to raise the industrial production in a short period, there are two ways: (1) to increase energy consumption by nearly the same percentage under the same energy structure, keeping pace with the projected increase in industrial production; (2) to use efficient energy and raise the production in higher ratio than the consumed energy. In both cases petroleum should be consumed more than the projected increasing ratio of the industrial production.

A review of post-war development of oil demand in Japan will be useful as a background for a study of future trends.

Oil demand in Japan probably reached about 10 million kls (62.9 million barrels) in 1955. This was 40 times the 252,843 kls consumed in 1945. Such rapid growth of demand is easily understandable if we analyze the changes of the oil demand. This can be done best by dividing recent history into three periods.

In the first period prior to 1937, the demand for oil had gradually risen year by year. The second period, between 1938 and the end of World War II, was a time of slump and consumption was reduced because of difficulties of importing oils. The third period comprises the 10 years since the war, in which demand began again to show an upward trend. This third period, moreover, may be divided into two stages, of about five years each.

During the first five years, the distribution of petroleum products was controlled as it was during the war and Japanese economy had not recovered yet from the war-damaged state. Consequently the growth of consumption was very slow. After 1950, keeping pace with the progressive economic rehabilitation, and as a result of decontrol, petroleum consumption has moved forward with great strides. The actual consumption in 1954 did not reach the extended trend of the pre-war demand (the first period), projected on the normal growth curve of

TABLE I

PETROLEUM DEMAND STRUCTURE IN JAPAN

(Sales of 13 Major Oil Companies)

Unit: KL/MT

	1949		1950		1951		1952		1953		1954		1955	
	Volume	%	Volume	%	Volume	%	Volume	%	Volume	%	Volume	%	Volume	%
Gasoline	250,691	18.3	457,499	19.4	791,993	22.8	1,427,832	27.4	2,006,668	23.7	2,368,557	24.9	2,650,796	26.3
Kerosine	52,541	3.8	82,173	3.5	108,115	3.1	106,395	2.1	346,244	4.1	476,285	5.0	517,371	5.1
Gas Oil	121,716	8.9	235,959	10.0	366,499	10.6	382,784	7.4	557,416	6.6	687,251	7.2	818,658	8.1
Fuel Oil	771,020	56.4	1,268,251	53.7	1,843,330	53.2	2,899,414	55.6	5,063,823	59.8	5,459,683	57.5	5,513,643	54.8
Lub. Oil	136,504	10.0	213,331	9.0	245,480	7.1	272,127	5.2	343,715	4.0	342,713	3.6	375,232	3.7
Grease	3,945	0.3	6,089	0.3	7,064	0.2	6,677	0.1	8,112	0.1	8,509	0.1	8,748	0.1
Paraffin	4,374	0.3	7,970	0.3	10,432	0.3	12,195	0.2	13,575	0.2	13,420	0.2	15,535	0.2
Asphalt	26,859	2.0	88,890	3.8	92,710	2.7	105,631	2.0	128,432	1.5	142,835	1.5	168,704	1.7
Total	1,367,650	100.0	2,360,162	100.0	3,466,163	100.0	5,213,055	100.0	8,467,985	100.0	9,499,253	100.0	10,068,687	100.0

the Japanese economy in the post war years.

So, it seems that the abrupt upward swing in post-war demand is merely a return to the normal consumption level to be expected under gradual expansion of the Japanese economy. Tracing the post-war demand for various other fundamental goods, we find that most of them show the same tendency as petroleum.

The trend lines based on the record of the last five years cross the projected pre-war trend line about at the middle of 1954 and 1955 on the graph (Figure 3).

A little different picture is shown in the demand for fuel oil, which seems to have decelerated in 1954. This was a result of the government's policy to discourage fuel oil consumption and to foster the domestic coal industry. The "Law for Restriction of Installation of Fuel Oil Boilers" became effective in 1955. This law aims to restrain the consumption of fuel oil to be used for boilers and as a result, 700,000 kls (4.4 million barrels) of oil will be switched to coal. The consumption of coal will be increased by one million metric tons.

As a consequence, it is presumed that the future demand growth of fuel oil will set a little lower line in parallel with the secular line. Although Japanese oil consumption has doubled, the five million kls consumed in 1937, the highest before the war, it still is below the normal level. Before the war the consumption of Japan was over 1.6% of the total world consumption, whereas Japan consumes only about 1% at present. This shows also that Japanese consumption has not reached to its previous pre-war level.

Demand Structure As indicated by Table I, the distribution of the main petroleum products in Japan has shown a peculiar picture compared with that in the United States and European countries because of the relative high demand for fuel oil against the comparatively small requirement for gasoline and gas oil.

There are two fundamental reasons for this peculiar picture. These include the high cost of coal production due to the random mining during the war and secondly the unpopularity of the internal combustion engines using gasoline and gas oil. This means that these engines are still underdeveloped compared with Europe. The distribution of oil demand among various products will be analyzed below:

(A) *Gasoline* Motor-cars are a big user of gasoline in Japan as well as in the U. S., but the component of gasoline use is a little different. In Japan the passenger cars are comparatively few in number and trucks and buses constitute a greater proportion. For instance, at the end of September 1955 there were 158,907 ordinary type trucks, 491,174 small type trucks, 33,833 buses compared with 82,822 ordinary type passenger cars and 65,191 small type passenger cars. Besides the above figures, motorcycles total 538,826 and motor bicycles, not listed in the table, are estimated at about 505,000, though gasoline consumption per unit is small. Attention should be given to the fact that the development and popularization of diesel powered buses and trucks is changing the picture of gasoline use. Excluding motor bicycles, the increases in gasoline powered motor cars have been small when compared with the rapid and continuous increase of diesel cars which have recently stepped into the motor car field in Japan. Since gasoline demand already has risen above the pre-war trend, it is supposed that the recent rapid increasing trend will be gradually decelerated in the future.

(B) *Kerosine* In an earlier day lamps were the only users of kerosine and subsequently agricultural motors became another user. The rapid development of electric lighting has reduced demand for lighting and agricultural use also has been gradually limited. By 1950, the outlook for kerosine demand was not bright. The trend line showed a small angle. The appearance of oil ranges for cooking and stoves for space heating in 1953 has developed a new demand for kerosine, and brought consumption up to nearly four times as much as that in 1952. Other petroleum products doubled when compared with the previous year. Accordingly it is assumed that about 80% of the present demand for kerosine is used for oil ranges and stoves.

(C) *Gas Oil* Demand for gas oil has been growing steadily and will continue this trend for several years. This remarkable tendency is supported by the increased use of diesels for trucks, buses and vessels. The completion of catalytic cracking units in Japan resulted in reducing domestic supplies of gas oil and in forcing its import to fill the gap between demand and supply.

TABLE II
Number of Automobiles in Japan

	Trucks				Passenger cars				
	1500cc up	4 wheels small	3 wheels small	Buses	1500cc up	small	Motor cycles	Others	Total
1936*	51,414	4,272	39,891	29,179	46,165	24,322	—	—	195,243
37	53,071	8,139	47,867	24,762	51,396	28,841	—	—	214,076
38	55,163	12,777	50,402	24,450	47,766	31,411	—	—	221,969
39	54,653	16,801	50,507	23,686	42,115	29,836	—	—	217,598
1940	60,761	17,064	50,400	23,191	39,920	25,372	—	—	216,698
41	54,687	17,458	48,212	23,648	37,714	18,848	unknown	—	200,567
42	56,806	19,046	45,883	23,437	28,043	14,556	—	—	187,771
43	60,834	19,857	41,992	22,025	25,030	14,621	—	—	184,359
44	45,866	20,087	37,185	17,206	22,350	11,391	—	—	154,085
45	45,701	13,032	28,500	11,882	18,113	11,346	—	6,535	135,109
46	78,419	11,144	20,000	12,099	19,985	9,357	—	7,263	158,267
47	95,705	13,710	41,137	13,115	20,605	11,302	—	12,408	207,982
48	109,050	19,139	58,806	15,050	22,155	16,004	—	19,002	259,206
49	115,151	24,134	81,488	16,936	25,131	43,930	—	17,347	324,117
1950	116,091	30,465	101,696	17,878	27,611	12,906	41,573	19,696	367,916
51**	124,995	37,940	137,348	21,450	32,273	19,025	72,104	20,209	465,344
52	136,701	46,746	192,257	24,117	54,132	26,408	148,276	23,483	652,120
53	149,792	55,485	267,247	27,499	69,688	34,365	303,327	26,072	933,475
54	160,980	66,754	346,193	31,086	84,230	49,552	476,240	34,043	1,249,078
55	158,907	84,702	406,472	33,883	82,822	65,191	538,826	33,011	1,403,814

Remarks: The column of "small passenger-car" figures before 1949 includes motorcycles.
* 1936-1950: as of the end of March, each year.
** 1951-1955: as of the end of Sept., each year.

TABLE III
Energy Consumption & Industrial Production in Japan

Item Year	Total Energy Consumption (Thousand Tons of Coal Equivalent)	Industrial Production Index (1934-36=100)
1934	59,696	89.8
35	65,319	99.0
36	69,771	110.5
37	77,482	129.7
38	81,763	142.4
39	86,271	147.8
1940	94,442	148.8
41	91,183	149.6
42	90,834	144.5
43	90,025	160.1
44	78,713	178.8
45	38,895	60.2
46	41,743	30.7
47	49,787	37.4
48	58,030	54.6
49	61,845	71.0
1950	68,743	83.6
51	79,500	114.4
52	82,651	126.4
53	93,966	155.1
54	95,508	165.2

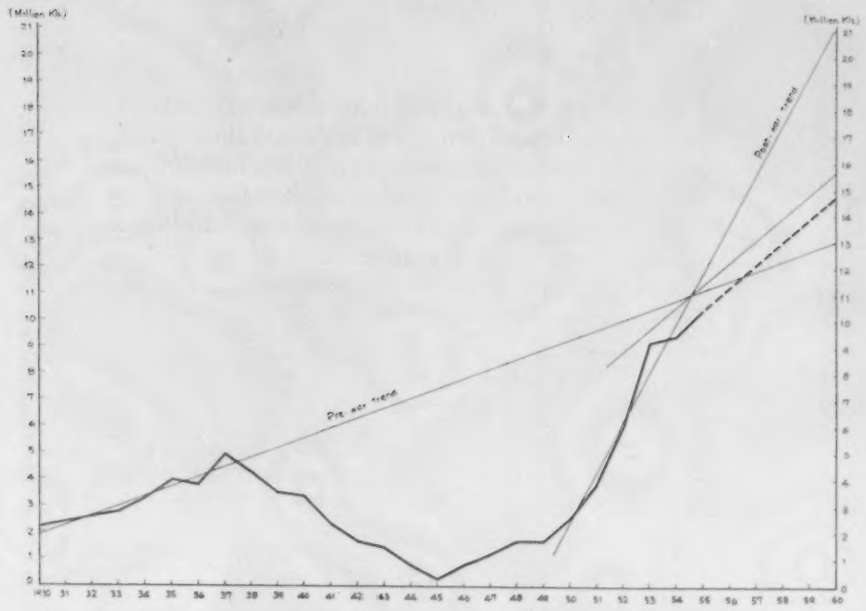


FIG. 3—*Petroleum consumption in Japan.*

(D) *Fuel Oil* Directly after the termination of the war demand for fuel oil grew rapidly, keeping pace with the rocevery of the industrial activities. Consumption has been depressed by the restrictive policy being enforced by the government during the past two years. Considering that this restriction covers only some uses of fuel oil and that the depressed demand for fuel oil was partially caused by the deflation in our national economy, the restriction will not work effectively and demand for fuel oil will be expected to climb again in spite of the coal workers' opposition. This is endorsed by the fact that the United Kingdom and Western Germany have shown a rapid growth of fuel consumption in recent years and are expected to continue the same tendency. Since the cost of coal in Japan is much higher than that in Europe, industries will demand fuel oil more strongly.

(E) *Lube Oil & Others* Demand for lube oil has also greatly increased in line with the restoration and development of industrial production and of transportation. Demand for asphalt or paraffin has also gradually grown year by year.

What of the future outlook for petroleum consumption in Japan? This may be considered under three categories:

(1) Forecast for 1956; (2) forecast for five years; and (3) long range forecast. In order to compare our estimates with other estimates of industrial production or business activities announced by the government or the other authorities, data in this article is also arranged in "fiscal year" beginning in April and ending in March next year.

(1) Forecast for this year. Monthly demand for main products in the near future is estimated by taking account of the seasonal variation to the estimated future trend line based on the past actual demand. Gasoline demand for 1956 is estimated by this method as shown in Fig. 2. Demands for other products shown in Column A, Table IV are also estimated in the same way. Column B indicates the government estimate. The figure of fuel in Column B is far smaller than that in Column A because the government expects to be able to curb fuel consumption. But under the present circumstance, it may be difficult to control it strictly and unavoidably fuel consumption will rise to some extent. Regarding gasoline, kerosine and gas oil, the figures are a little less than those of Column B. Without any remarkable change in economic activity, the demand for these products will not be so high as the government's estimates. However, it is assumed that with the rapid development and popularization of the diesel engine, gas oil demand will surpass the future trend line estimated by the past actual demand. But in forecasting gas oil demand, it must be taken into account that a retail tax on gas oil, which is now being discussed by the diet, may be imposed this spring.

TABLE IV
Estimated Japanese Petroleum Demand in 1956
(In 1,000 Kls.)

	Mitsubishi Oil Co.'s Estimation	Government's Estimation
Gasoline	2,908	3,030
Kerosene	506	680
Gas Oil	880	1,000
Fuel Oil	6,374	5,640
(Sub-Total)	(10,668)	(10,350)
Others	566	n.a.
Grand Total	11,234	n.a.

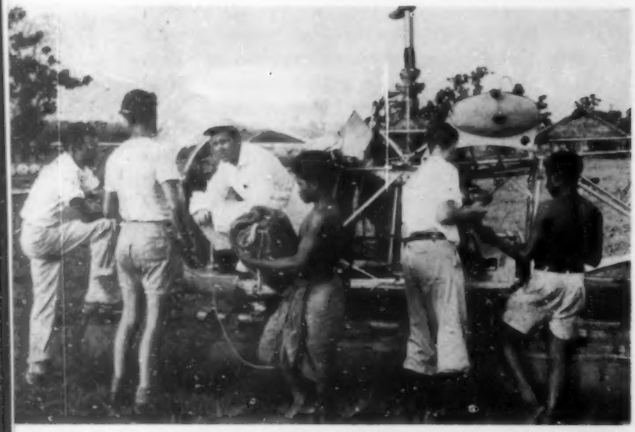
Remarks:
(1) n.a.: Not available
(2) 1 Kl: 6.29 bbls.

(2) Five-year forecast. As may be seen in Fig. 3 the trend line of demand growth during the next five years seems to be set between the pre-war and post-war trend lines. (The author's estimate is indicated by the dotted line). The total demand for oils in 1960 will be 14.7 million kls (92.5 million barrels) according to this line. The similar phenomena are shown in other materials, for example, cement. As mentioned previously the Economic Planning Board has assumed a lower energy demand compared with the growth of production, and estimated the oil demand in 1960 about 13.7 million kls (86,168,890 barrels) which is nothing compared with the result of depending more upon coal and water-power. But, if Japan does depend upon such energy resources, they could not realize the expected industrial production from the projected energy supply.

(3) Long range forecast. Because there is no accurate and reliable data available to estimate future demand over an estimated period, it is impossible to draw a diagram of long range demand. Therefore, some facts must be pointed out affecting possible future tendencies. Above all, attention must be paid to the fact that the Japanese domestic energy supply will reach its economic limit in five or six years. In such a case they will be compelled to depend upon the cheapest available imported energy resource, which is petroleum now and which will continue to be petroleum in the near future. Some day atomic power or other new energy may possibly become the cheapest source of energy. Atomic energy will be imported also, and will be used with petroleum, but it is not supposed that atomic energy will be an important factor for another 20 years.

Per capita consumption of energy in Japan in 1953 based on coal was 0.96 ton which is not small when compared with the world level. Oil consumption per capita is extremely low, only 0.82 barrel in 1954, and it sets Japan 39th among 51 nations. It suggests also that Japanese energy in the future will depend upon petroleum more than at present. The Paley Report has estimated that Asia, Africa, and Australia are the districts in which petroleum consumption will be increased more rapidly than in other districts of the world and demand for petroleum in 1975 will climb to 409%, as compared with 1950.

Japan also belongs to this area, but the consumption of petroleum in Japan was reduced unnaturally at the time (1950). So we take the basic consumption in 1937, the last year of the pre-war period, and multiply it by 409%—the answer, the estimated consumption in 1975, is 20.4 million kls. (128,309,880 barrels). If we start from the estimated consumption in 1960 as mentioned above and draw a parallel line with the pre-war trend, it reaches also a little higher point than 20 million kls. in 1975. Thus, we can say roughly that the oil consumption in Japan will become a little in excess of 20 million kls. (125.8 million barrels) in 1975.



Two Bell helicopters, similar to that shown above, are used by geophysical parties to transport men, equipment and supplies along survey lines through jungle terrain and swamps. All photographs used in this article are through the courtesy of British Petroleum Co.

Two major companies and a local concern have pushed an exploration effort in Papua since 1936 without discovering production. They face the usual problems of jungle operations, such as lack of suitable headquarter sites, difficult roadbuilding into drilling sites, and construction of housing before their main problem, drilling, even begins.

PROBLEMS IN PAPUA

THE exploratory campaign in Papua has continued despite repeated failure to find production, in efforts dating back to 1919. The principal companies involved are Island Exploration Co. Pty. Ltd. and Australasian Petroleum Co. Pty. Ltd. owned by British Petroleum, Standard Vacuum and Oil Search, an Australian company. They evidently have faith in the areas, ability to develop substantial production, since they have continued to face some of the most difficult and expensive of operation problems in jungled areas. Expenditures by the end of 1955 had reached about $35.8 million.

Originally the companies were interested in the area east of the Purari River, but five wells, one drilled to 12,621 feet, indicated formations were lacking with sufficient porosity and permeability for commercial oil accumulation. Two wells west of the Purari River, Wana and Omati, showed reasonable thickness of sediments, oil indications and suitable reservoir formations. The companies' efforts are therefore concentrated in this area. Wells are presently projected at Barikewa, Morehead and Kuru. The latter recently had substantial gas shows at about 998 feet.

Much of the terrain is low and swampy. The companies originally contemplated establishing a headquarters near the site of operations, but insufficient high ground could be found on the coastline between the Purari Delta and the Fly River without land reclamation on an expensive scale

This review of Papuan operations is based on an account by L. A. Pyme, general manager for Australasian Petroleum originally published in Australia's Chemical Engineering and Mining Review. *Editor.*

Administrative and technical supervision, along with equipment and maintenance are therefore located 500 miles away in Port Moresby.

A transshipment base was established eight miles north of Kikori for quickly needed supplies and spare parts.

Another problem of operation in this type of area is communication. Radio-telephone service is maintained on a 24-hour basis. It enables contact with all forward parties and technical discussions between operating parties and headquarters at any time.

For transportation helicopters have been used extensively. Two Bell helicopters, each with a carrying capacity of 400 pounds, are used by geophysical parties to transport men, equipment and supplies along survey lines through jungle terrain and swamps.

An additional air fleet is used, comprising two chartered Catalinas, and a Beaver float plane for areas too small for the Catalinas. A fleet of small vessels transports bulk cargoes of equipment and supplies from Port Moresby across the Gulf of Papua and along inland waterways as close as possible to the scene of forward operations. These have to be seaworthy enough to withstand heavy seas during the monsoon, and of shallow draft to navigate rivers. Only the larger are capable of slinging 20 tons over the side. Considerable use is made of landing craft vessels with a front door similar to the LCT used in the war.

A hydrographic party is employed to chart the southwestern coastline of Papua, which is largely unknown and contains many treacherous waters and shoals. The party uses radar and echo sounding devices and keeps charts on moving shoals and river bars.

Since drilling sites are seldom actually on a river bank, considerable road building is necessary. Generally roads longer than 10 miles are not necessary. Roads invariably have to be constructed through dense tropical rain forests. The terrain is often rugged, with surface soils of either marls and clays or hard limestone. Rainfall is from 200 to 300 inches yearly.

In road construction the rights of way are cleared of trees and undergrowth to a width of about 200 feet to admit sun and wind and dry out surface soil. Roadways are paved with surfacing material to about 15 feet width and grades and curves are designed to take up to 20-ton trucks. The usual earth moving equipment is used on these roads. The only abnormal problem is the high rate of rainfall which makes the operation of machines in soft clay formations very difficult and makes it necessary to reduce earth moving requirements to a minimum. Another problem is the special attention necessary to drainage and culverting.

In constructing the road to the location presently drilling at Kuru, some 7½ miles were covered. The major problems were, first, maintenance of tractors in operation in the boggy subsoil after heavy rainfall and, second, finding sufficient surfacing material, which had to come from a nearby creek bed during the low river level. The Barikewa road, now being constructed, presents the problem of excavation through very hard limestone with blasting necessary before bulldozing.

The cost of road building makes the use

One of the river boats used in Papua with a survey party returning to Kuru camp is shown above.

of helicopters especially attractive. In nearby Dutch New Guinea the Nederlandsche Nieuw Guinee Petroleum Maatschappij, N.V., owned by Shell, Standard-Vacuum and Caltex, is currently drilling a well which is entirely serviced by helicopter, thus eliminating road cost entirely. In the opposite area of the earth, Canada, helicopters have been used to transport men and supplies in areas of equal difficulty, the muskeg of the Pembina type.

Still another consideration of note is the need for suitable housing for personnel. Drilling camps in Papua are more substantial than elsewhere because of isolation and climatic conditions. Total personnel needed for a well of 12,000 feet or over is about 36 staff and 200 natives, the former comprising supervisors, drilling crew and auxiliary technicians such as resident geologist, mud engineer and Schlumberger operator, servicing engineer for water supply and transport, a road maintenance gang and administrative staff, such as office assistant, native labor supervisors, medical assistant, storekeeper and caterer.

The principal problems revolve around drilling. Drilling outfits held by the companies in Papua are three National 50's for shallow test drilling to depths of the order of 7,000 feet and one National 100 and one National 130 for deep test drilling to depths of over 12,000 feet. Drilling procedure, tools and casing design are much the same as are used in exploratory drilling elsewhere with some variation in procedure and selection of tools to suit local formation conditions. No problems have been made that have not been experienced elsewhere in oil field drilling.

One major problem has been the penetration of the "running mudstones" or "heaving shales" in the Aure Trough region. These unstable shales are encountered over the cresstal area of structures in many parts of the Aure Trough and, in fact, are diapiric cores of incompetent sediments formed by intense thrusting and folding. They can be rapidly penetrated by the bit but close-in almost immediately with resultant freezing of the drilling

A deep laden shallow-draft bomb scow with men and equipment moving along a Papuan river towards an oil survey camp.

Exploratory well, Omati No. 1, was abandoned dry at 14,352 feet.

Typical of the swampy terrain in Papua is the scene above, showing a geophone station in a grass swamp. It illustrates the advantage of helicopters in these regions.

string unless remedial action is taken. This particular problem was the direct cause of many of the early test holes drilling in Papua between 1923 and 1939 coming to a halt at a shallow depth. The most effective remedy is to use an extremely heavy circulating fluid (a mud fluid weighted with barytes and treated with numerous chemicals) but unfortunately these shales are extremely bentonitic which causes a rapid rise in viscosity until the mud fluid becomes unpumpable unless constantly treated with chemicals and frequently changed. Hohoro No. 2 well was drilled through more than 8,000 feet of these shales to reach a final depth of 10,642 feet, mud chemicals consumed in the course of drilling comprising 3,360 tons of barytes, 130 tons of distillate, 70 tons of lime, 50 tons of myrtan, 48 tons of caustic soda, 17 tons of starch and 14 tons of aquagel.

Extremely porous limestone formations at shallow depths in both the Omati and Aramia drilling have been the cause of some difficulty. These formations are too permeable to permit sealing with the usual materials used for the purpose with the result that circulating mud, fluid, containing expensive chemicals, is lost to them at an exceedingly fast rate, not only making drilling costly, but also resulting in shut downs, because of the difficulty in maintaining bulk chemical supplies to these isolated localities. The problem has been overcome by circulating large volumes of water in place of mud, the water flushing drill cuttings to the permeable formation instead of bringing them to surface as is the case with complete mud circulation. The disadvantage of the practice is that until the open formation can be cased off, a high proportion of coring—a slower process than straight drilling—is necessary to obtain sample material for stratigraphical information.

The petroliferous gas met under exceedingly high pressure in Omati No. 1 well at 13,743 feet was the cause of considerable delay. It was of course impossible to determine without drilling deeper whether this gas showing was confined to a thin porous formation or was in the top of a more important reservoir system. The surface control valves on the well at the time were designed for an operating pressure of 5,000 pounds per square inch, but in view of the many unknowns, it was too risky to life and equipment to continue drilling until replacement valves designed for an operating pressure of 10,000 pounds per square inch could be installed. It was necessary to have these valves manufactured in the United States. Drilling was eventually continued to 14,352 feet, the maximum depth to which it was operationally possible to carry the hole, but without encountering additional gas shows.

Omati No. 1 was originally designed for a much shallower depth than that to which it was eventually drilled and the feasibility of carrying the hole beyond the gas show at 13,743 feet was always in doubt. Consequently, Omati No. 2 well was commenced largely as an assurance, while No. 1 was shut down awaiting equipment. This second hole was abandoned at 10,880 feet after the results of Omati No. 1 had established that commercial oil was not within reasonable reach of the drill in this par-

The experience of Australasian and Island Exploration can only point out one fact: The need for long-range planning and determination to see an exploratory program through to its end, with sufficient resources. This is an aspect not always realized by independent companies contemplating foreign operations.

Shown above is a native setting into position a geophone for seismic recordings.

During his negotiations with the Russians J. B. O'Connor, executive vice president of Dresser Industries, visited oil fields in the Bushkir Republic where he observed the turbodrill in operation. The photograph in the field shows (left to right) Engineer Sobnin; Engineer Iornisian, developer of the turbodrill; Mr. O'Connor and Engineer Gusman, co-developer of the turbodrill.

Dresser Obtains U. S. Rights To Russian Turbodrill

DRESSER INDUSTRIES, INC., Dallas, has obtained rights to manufacture the turbodrill in the United States for a period of 10 years. Contract covering the deal was obtained by J. B. O'Connor, executive vice president of Dresser, from Machinoexport following a visit by the American equipment man to Russian oil fields where he saw the bit operating.

The agreement will not go into effect unless it is approved by the United States Department of State.

Dresser agreed to supply the U.S.S.R. with technical know-how for the production of drilling bits in Russia of characteristics similar to those now being made in the United States. The Russians, in turn, agreed to send technicians to the United States to aid in manufacturing and using the turbodrill.

First news of the agreement was broadcast by the Moscow radio following signature of the agreement on March 2. Mr. O'Connor had been in Russia working out details of the contract since February 17.

The Russian turbodrill was first used in Well No. 57 in the second Surahan field in August 1923. By 1927 drilling with the new type bit had reached a total of 13,500 feet and in fiscal 1929 turbine bits drilled 40,000 feet. In that year one well was drilled to 3,450 feet with the new mud-powered turbine. As early as 1930 it was announced that arrangements were in progress to have the bit manufactured in the United States.

An article describing the bit and its performance was published in WORLD PETROLEUM in June 1930 under the signature of M. Capelushnikov, consulting engineer, and M. Gayman, mining engineer, both of the Azneft Oil Trust.

In the issues of March and April 1955 a series of two articles by Dr. G. G. Rosu traced the development of the bit through many models from 1923 up to 1954. By that time it was reported that 80% of the development wells in Russia and 65% of all wells were drilled with the turbine.

It has been stated that advantages of the turbodrill are that lighter drill pipe is required, drilling speed is high and holes are straighter when weights are applied below the turbine. Surface power requirements are lower since the drill pipe is not rotated, but mud pump requirements are greater than with conventional rotary drilling. Accident rates are lower. In some cases drilling costs are reduced by drilling twin holes from a single location by drilling in one borehole while making a trip in the other.

In some areas water is used as a drilling fluid to reduce power loss between mud pumps and the turbine. Recently centrifugal pumps have been employed on low viscosity fluid pumping. Desanding of the fluid is done carefully to protect turbine bearings.

Development work on a mud-powered turbodrill was begun in the United States at about the same time as in Russia. C. C. Sharpenberg of Standard Oil Co. of California was granted a patent on such a device in 1924 and two years later experimental drilling was done in Elk Hills. In 1935 A. O. Smith Corp. began working with Standard of California. The work was interrupted by the war in 1941 but was resumed again in 1949. Eleven patents have been obtained on various features of the turbodrill since 1942.

A detailed report on the research was given before the petroleum division meeting of the American Society of Mechanical Engineers at New Orleans last September by W. R. Postlewaite. In detailing reasons behind the work, the author said that during World War II, it was estimated that the turbodrill could save $6,000 to $10,000 per well. He pointed out that in conventional drilling only 10% of the power applied at the rotary table is effectively applied to the bit. In deep holes several hundred horsepower may be required at the surface to deliver 10 to 25 hp at the bottom of the hole. Likewise mud at 500 psi at the pump retains only 30 psi in jet action at the bit.

The turbodrill was reported to be about 50% efficient and mud pressure may have to be increased to operate the turbine.

Standard of California has developed a turbine speed indicator permitting proper coordination of bit weight and speed to achieve maximum penetration.

In the Standard of California research, turbines with up to 50 stages have been built although 10 to 20 stages have developed adequate power for most drilling situations. Field experience has been gained in drilling 14,000 feet in six wells.

The turbodrill which Dresser Industries has been licensed to manufacture is similar in principle to the one used by Standard of California but it is entirely different in construction. The basic design and several modifications of this turbodrill were described in a paper presented by Prof. F. A. Trebin at the Fourth World Petroleum Congress June 1955. These turbodrills utilize from 90 to 240 stages depending upon torque requirements. They are reliably reported to drill up to 10 times as fast as rotary.

Dr. William F. Ryan, is vice president and senior consulting engineer of Stone & Webster Engineering Corp., Boston. He received his engineering degree from Harvard in 1913, and has been continuously engaged, since that time, in construction operation and design of power and industrial plants. He was a pioneer in the application of high pressures to industrial power generation, and is the inventor of the dual-circulation boiler.

Leo S. Maciejewski received his M.E. degree from Stevens Institute of Technology in 1942 and served in the United States Navy throughout World War II, assigned to engineering duty aboard the battleship U.S.S. Wyoming. After his discharge in 1946 with the rank of Lieutenant Senior Grade, he joined Stone & Webster Engineering Corp. and has designed mechanical features for a number of public utility and industrial power plants, including Stanolind Station No. 3.

POWER GENERATION FOR OIL

Oil refiners have been slow to build power plants utilizing high temperatures and pressures which public service companies have found economical. Only one U. S. refinery uses steam for power at a pressure in excess of 1,200 psi. In the public utility field 2,000 now is common.

By W. F. Ryan and L. S. Maciejewski

"There is nothing to learn from power plant practice in American oil refineries."

THAT rather sweeping statement by a recent visitor from abroad is not altogether unjustified if only plants owned and operated by the refiners themselves are considered. The petroleum industry in the United States has produced no power generating plants which are in keeping with the technological achievements of its process engineers or which develop the potentialities for low cost electric power in an operation which has such a heavy demand for process steam. From a limited knowledge of refinery practice abroad, we have been able to discover no particularly notable installations in other countries, either.

Petroleum engineers and petroleum metallurgists developed equipment for utilizing high pressures and high temperatures several years before the public utilities were interested. When steam pressures in central power stations moved up from 450 psi to 1,200 psi, about 1925, the practical limits for riveted boiler drums were exceeded, and the art of welding had not been developed to a point where there was sufficient confidence in the technique to warrant its use for vessels containing large quantities of high temperature water. The use of high

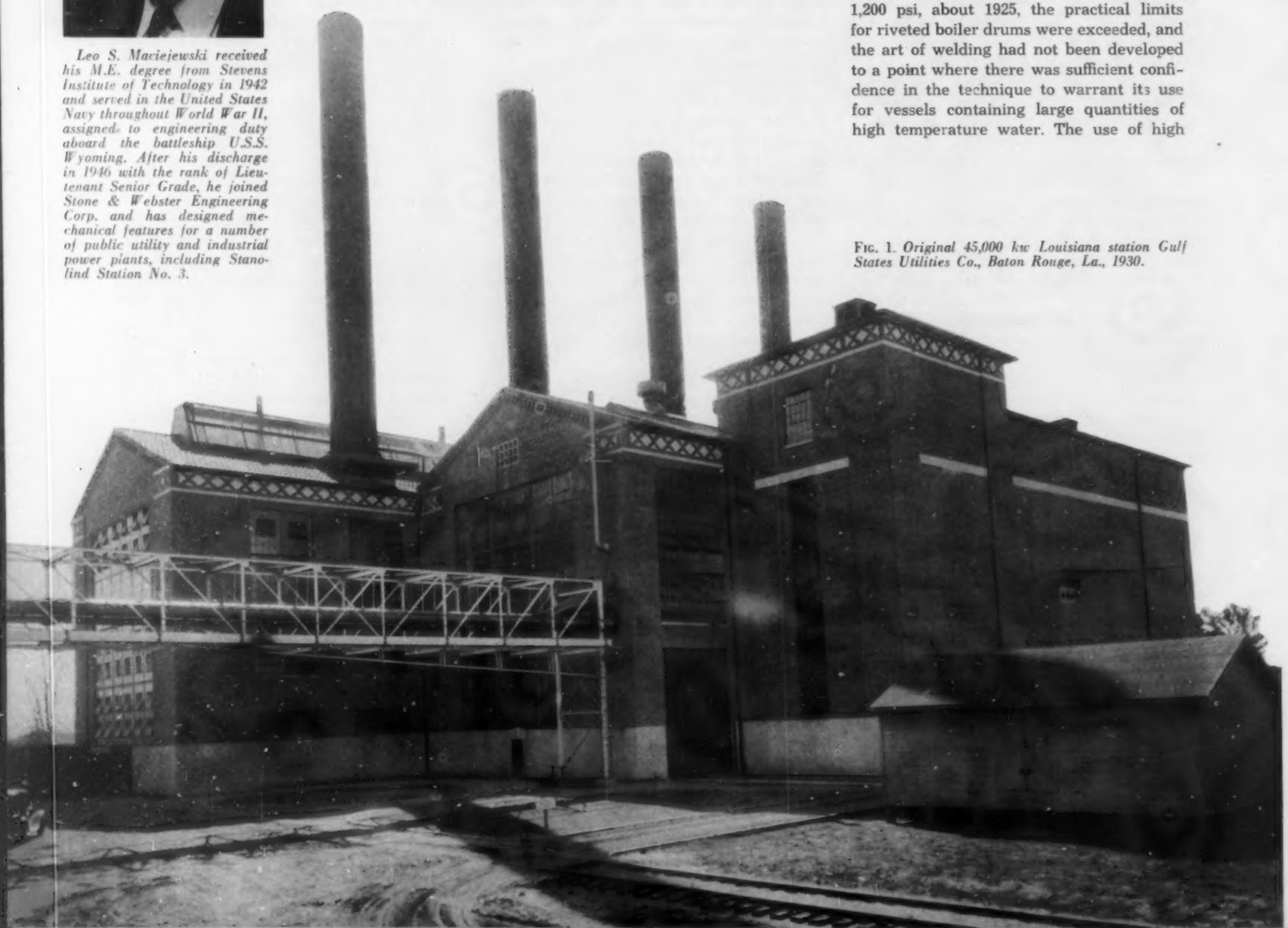


FIG. 1. *Original 45,000 kw Louisiana station Gulf States Utilities Co., Baton Rouge, La., 1930.*

REFINERIES

FIG. 2. *Present 406,000 kw Louisiana Station, 1955. Part of water treating plant—left. Part of Esso refinery—top.*

steam pressure was feasible, in 1925, only because the petroleum industry had developed the art of piercing and drawing solid billets to form single forgings of sufficient size for large boiler drums. For several years, all boiler drums for working pressures above 600 psi in the United States were manufactured by the process borrowed from the refineries, but it was not until after World War II that any refinery in the United States installed a power plant utilizing steam for power at 1,200 psi. To this day, there is only one such installation reported in this country.

The same comment applies to utilization of high temperatures. Temperatures of 1,100°F were not uncommon in refinery practice in the early 1920's. The highest steam temperature used for power generation in any American refinery power plant is 900°F, and, to the best of our knowledge, there is only one instance of that temperature being used.

While the refineries have been dragging their feet with respect to pressures and temperatures, public utilities have gone higher and higher. Pressures in excess of 2,000 psi are now common, and two major power stations are being designed for supercritical pressures, one at 5,000 psi and one at 5,500 psi. Also, public utilities have plants now under construction designed for steam temperatures up to 1,200°F. Steam temperatures of 1,000°F and 1,050°F are almost conventional in recent utility generating plants.

The remarkable thing about the backwardness of refineries in utilizing high pressures and temperatures is that they have so much more to gain than the utilities. The typical refinery power plant uses steam at about 450 psi to generate power in turbines which exhaust at pressures of 100 psi or more. In the utility central stations, turbines exhaust at high vacuum. When a refinery with prime movers exhausting at 135 psi increases its steam pressure from 450 psi to 2,500 psi and the temperature from 750°F to 1,000°F, the theoretical increase in yield of kilowatthours per 1,000 lb of steam is 57%. The same increase in a central station where the prime movers exhaust at 2 in. Hg would result in a gain of only 23%.

While the refineries have failed to take advantage of the special conditions prevailing in their industry, fortunately, public utilities have done that for them. There are several installations in the United States owned and operated by public utilities where large quantities of power are generated in back pressure or extraction turbines which supply steam to a refinery. Excess power beyond the refinery demand is distributed to the utility system. The fuel net consumption for power so generated is normally less than 4,000 Btu per kwhr, whereas condensing turbines, even when operated at supercritical pressures, consume more than 8,000 Btu per kwhr.

The first major installation by a public utility for supply of steam and power to a refinery was the Louisiana Station at Baton Rouge, now owned and operated by Gulf States Utilities Company. This plant started operation in 1930, with three 15,000 kw turbine generators utilizing steam at 600 psi and 725°F, exhausting at 135 psi to the steam mains of the Baton Rouge Refinery now owned by Louisiana Division, Esso Standard Oil Company. At that time, the refinery steam demand averaged about 700,000 lb per hour, with a maximum of 840,000 lb per hour. The original plant is shown in Fig. 1.

The reason for the relatively low steam pressure used on the initial installation was that the only source of boiler feed was the hard and muddy water of the Mississippi River. Since no condensate was returned from the refinery, the entire boiler feed consisted of treated make-up, except for the steam condensed internally by feed water heating devices. Methods of feed water purification available in 1930 did not warrant any higher pressure at that time and, in fact, the original water treating plant at Baton Rouge represented a notable advance in the art of boiler feed water purification. Louisiana Station has now grown to a total capacity of 406,000 kw, and 5,300,000 lb of steam per hour is available for delivery to the refineries and other neighboring industries. The local industrial load averages about 120,000 to 125,000 kw and the surplus power generated is delivered to the Gulf States system. The present plant is shown in Fig. 2.

The latest turbine generators installed at Louisiana Station are designed for 1,450 psi, 950°F at the throttle, exhausting at 135 psi, and they have a capability of 55,000 kw, each. The feed water make-up is from the same source, the Mississippi River, supplemented by well water, but it is demineralized in the largest installation of its kind for power purposes in the world. The turbines are supplied with steam by three outdoor type steam generators, each having a maximum rating of 600,000 lb of steam per hour when firing natural gas, oil or petroleum coke.

Recent extensions of the station are of the semioutdoor type, with the turbine and auxiliary equipment completely enclosed, but the steam generator, forced and induced draft fans and deaerating heaters are out of doors. The boiler firing aisle is also enclosed.

The feed water make-up for the 1,450 psi boilers is supplied from a 3-stage deionizing plant consisting of 2-bed type cation and anion exchangers and vacuum deaerator for either well water or clarified Mississippi River water, delivering 3,500 gpm of high quality water in addition to water used for back washing and rinsing exchange units or otherwise discharged to waste. The deionizing plant consists of eight cation exchange units, two cold water vacuum deaerators, and eight anion exchange units with the associated piping, valves, pumps and instruments. The deionizing plant effluent is discharged to three 500,000 gal capacity water storage tanks, from where it is pumped through a blowdown heat exchanger to the main deaerating heater, thence into the high pressure boilers.

Fig. 3 is a plan of the water treating area, which is now a full-fledged chemical plant, comparable in size, cost and operating complexity with many important installations for chemical manufacture.

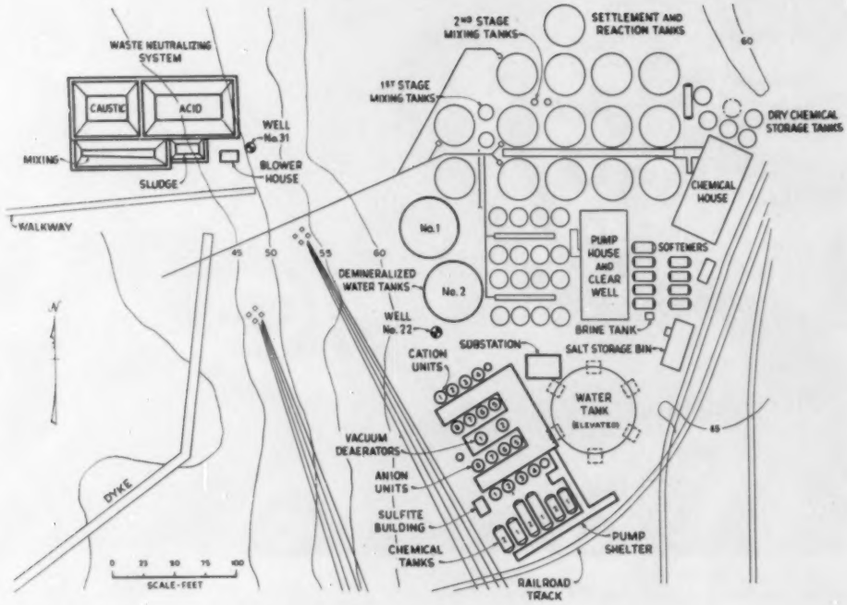


FIG. 3. *Water treating plant, Louisiana station.*

The electric generating capacity of the present station is 406,000 kw. The steam generating capacity of the boilers would be sufficient to supply 700,000 kw of condensing power, if no steam were sold to the neighboring industries.

The yield of power per 1,000 lb of steam for the first unit was not over 33 kwhr, but the use of higher pressure and temperature, together with improved heat balance, has increased the yield to 79 kwhr per 1,000 lb of steam in the 1955 addition. Fig. 4 shows the heat balance for the initial station, while Fig. 5 shows the heat balance for the two latest units. Louisiana Station was the first major installation of its kind and is still the largest, both in electric generating and steam generating capacity.

In 1940, the Pacific Gas and Electric Co. built a generating plant at Avon, Calif., to supply process steam and electric power to the oil refinery of the Tide Water Associated Oil Co. This station, located adjacent to the refinery, has three natural gas, oil and acid sludge fired radiant boilers, each having a capacity of 200,000 lb of steam per hour at 1,525 psi gage pressure and 950°F total steam temperature, supplying steam to one 50,000 kw, 3,600 rpm turbine generator. The generating unit is tandem compound, with a high pressure extraction element coupled to a single flow, low pressure condensing machine. Steam for the refinery is supplied from evaporators which condense steam extracted from the cross over between the high and low pressure elements.

The turbine, switchgear and control boards are housed, but the boilers, evaporators, fans, water treating equipment and feed water heaters are constructed for out-of-door operation. The station supplies 275,000 lb of steam per hour at 160 psi gage, with 50°F superheat and 15,000 kw of electric power to the refinery. Surplus power is delivered to the utility system. A unique feature of this station is that the high and low pressure steam cycles are separated to insure reliability both of steam supply to the refinery and power output of the plant. As shown in the flow diagram, Fig. 6, in the high pressure steam cycle the condensate, after leaving the condenser, is pumped through three stages of feed water heaters and thence into the boiler. The water for the process steam, or low pressure cycle, is first treated and then passes through four stages of evaporator feed water heating to the evaporators. Three horizontal coil type evaporators are installed, each with a capacity to produce 102,000 lb per hour of process steam at 165 psi gage. Based on 46,000 kw average output, the yield of power per 1,000 lb of steam is 77 kwhr under usual refinery steam loads.

Subsequently, Pacific Gas and Electric Co. has installed two additional plants of this type, one at Martinez, Calif., to supply steam and power to a Shell Oil Co. refinery, and one at Oleum, Calif., which supplies steam and power to a refinery of the Union Oil Co. of Calif. Except for minor items and the circulating water system for the condenser, all three plants are identical in design.

The fullest advantage yet realized from the inherent situation in steam supply to oil refineries is exemplified by the Linden station of Public Service Electric and Gas Co., now under construction at Linden, N.J. This plant will supply steam and power to the Bayway refinery of Esso Standard Oil Co., with surplus power being delivered to the utility system.

The station will contain two 225,000 kw, 3,600 rpm tandem compound, triple flow, turbine generator units. The first unit is designed for initial steam conditions of 2,000 psi gage and 1,050°F and will have a maximum throttle flow of approximately 2,700,000 lb of steam per hour. Extraction will be automatically controlled at 750 psi gage and 150 psi gage for refinery process use. The maximum extraction flows at these two pressures will be 600,000 and 1,000,000 lb per hour, respectively. The second unit is similar to the first except its initial steam conditions are 2,350 psi gage, 1,100°F and 1,050°F reheat, with automatically controlled extraction at the lower pressure only.

Steam will be supplied to the first unit and for process purposes by three pressurized furnace steam generators constructed for outdoor installation and capable of burning high viscosity residual fuel oil, Bunker "C" fuel oil, natural gas and refinery gas. The units can be converted to pulverized coal firing in the future. A single steam generator will supply steam to the second unit. This boiler is designed for 2,700 psi gage and will deliver 1,900,000 lb of steam per hour at 2,390 psi gage and 1,100°F at the outlet of the superheater and reheat steam to 1,050°F.

Fig. 7 is an artist's sketch showing the general design of the station.

No details of the heat balance have been published, but the high initial pressure and temperature assure a materially higher yield of power per unit of process steam than is now obtained at Louisiana Station or the Pacific Gas and Electric Co. plants. The large size of the generating units will assure low capital cost per kilowatt and low cost of operating labor per kilowatthour. The Linden station will undoubtedly afford the fullest realization yet achieved for low cost power generation inherent in refinery operations.

The most advanced design of a power plant installed in an American refinery, owned and operated by the refiner, is at the Whiting refinery of Standard Oil Co. (Indiana). This plant, known as Stanolind Station No. 3, started operation in 1948. It is the only American refinery power station known to be using steam for power generation at a pressure in excess of 1,200 psi.

The initial station contained three fuel oil and refinery gas fired, dual-circulation type steam generators, each with a capacity of 300,000 lb of steam per hour at 1,350 psi gage and 900°F, and two 10,000 kw topping turbine generators exhausting steam to the refinery at 400 psi gage. A 2-stage hot process type water treating plant supplies 100% feed water make-up to the boilers. Raw water supply is from Lake Michigan. In

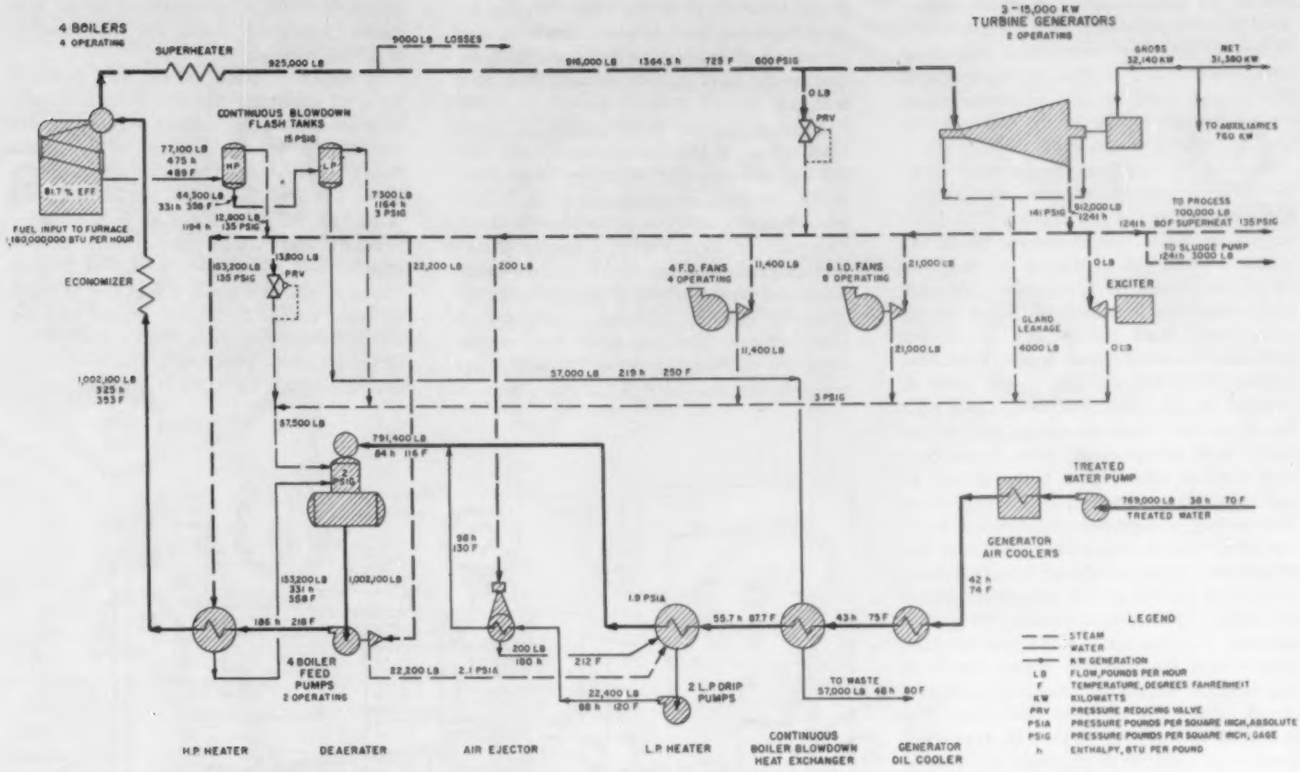
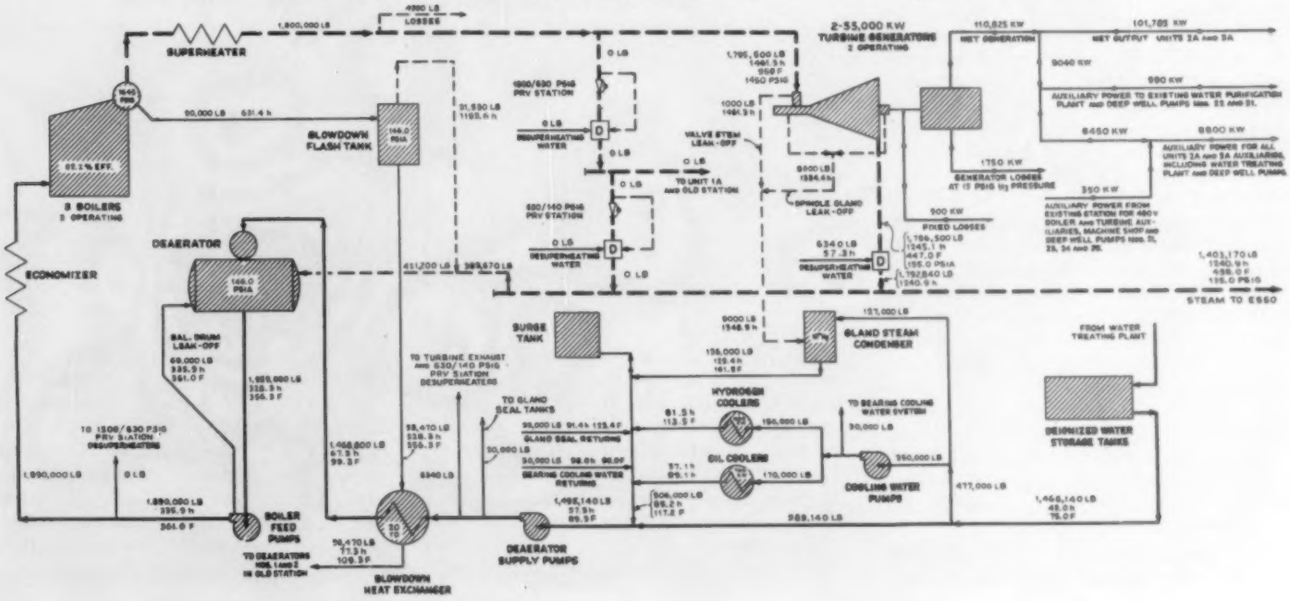


FIG. 4. *Heat balance diagram, initial installation, Louisiana station.*

the topping cycle operating at 1,250 psi gage and exhausting at 400 psi gage, a yield of 75 kwhr per 1,000 lb of process steam is realized. Subsequent extensions to the station have added two additional 300,000 lb per hour boilers and one 10,000 kw turbine generator.

The dual-circulation steam generators were selected for this installation because the design is specially advantageous for high pressure boiler operation with 100% feed water make-up. The steam generator, shown in cross section in Fig. 8, is divided into two separate heat absorbing sections, each with its own independent circulation and blowdown system. In the primary section, including the furnace, the rate of heat transfer is high, and concentrations must be kept low. The primary section is, therefore, blown down into the secondary section, where the low rate of heat input to the convection bank permits the concentra-

FIG. 5. *Heat balance diagram, latest units installed at Louisiana station.*


LEGEND
STEAM
WATER
POWER, KW
LB FLOW, POUNDS PER HOUR
h ENTHALPY, BTU PER POUND
F TEMPERATURE, DEGREES FAHRENHEIT
TD TERMINAL DIFFERENCE, DRAIN OUTLET AND FEEDWATER INLET
KW KILOWATTS
"Hg PRESSURE, INCHES OF MERCURY, ABSOLUTE
PSIA PRESSURE, POUNDS PER SQUARE INCH, ABSOLUTE
PSIG PRESSURE, POUNDS PER SQUARE INCH, GAGE
PRV PRESSURE REDUCING VALVE
D DESUPERHEATER
SUPERHEATER
1,800,000 LB
4000 LB LOSSES
2-55,000 KW TURBINE GENERATORS
2 OPERATING
110,825 KW NET GENERATION
101,705 KW NET OUTPUT UNITS 3A AND 3A
9040 KW
990 KW
AUXILIARY POWER TO EXISTING WATER PURIFICATION PLANT AND DEEP WELL PUMPS NOS. 23 AND 24.
8450 KW
8800 KW
AUXILIARY POWER FOR ALL UNITS 3A AND 3A AUXILIARIES, INCLUDING WATER TREATING PLANT AND DEEP WELL PUMPS
1750 KW
GENERATOR LOSSES AT 15 PSIG Hg PRESSURE
350 KW
AUXILIARY POWER FROM EXISTING STATION FOR 480 V BOILER AND TURBINE AUXILIARIES, MACHINE SHOP AND DEEP WELL PUMPS NOS. 21, 23, 24 AND 25.
900 KW FIXED LOSSES
1,403,170 LB 1340.9 h 438.0 F 135.0 PSIG
STEAM TO ESSO
90,000 LB 631.4 h
BLOWDOWN FLASH TANK
148.0 PSIA
82.1% EFF
8 BOILERS 5 OPERATING
DEAERATOR
148.0 PSIA
ECONOMIZER
451,200 LB
389,670 LB
1000/630 PSIG PRV STATION
31,530 LB 1193.6 h
0 LB DESUPERHEATING WATER
0 LB
0 LB
0 LB
TO UNIT 1A AND OLD STATION
630/140 PSIG PRV STATION
0 LB DESUPERHEATING WATER
0 LB
1,795,500 LB 1461.5 h 950 F 1450 PSIG
1000 LB 1461.9 h
VALVE STEM LEAK-OFF
9900 LB 1384.4 h
SPINDLE GLAND LEAK-OFF
6340 LB 57.3 h
DESUPERHEATING WATER
1,196,500 LB 1245.1 h 447.0 F 135.0 PSIA
1,192,840 LB 1340.9 h
SURGE TANK
9000 LB 1348.9 h
135,000 LB 128.4 h 161.5 F
151,000 LB
GLAND STEAM CONDENSER
FROM WATER TREATING PLANT
TO TURBINE EXHAUST AND 630/140 PSIG PRV STATION DESUPERHEATERS
TO GLAND SEAL TANKS
HYDROGEN COOLERS
150,000 LB
TO BEARING COOLING WATER SYSTEM
30,000 LB
DEMINIZED WATER STORAGE TANKS
OIL COOLERS
110,000 LB
350,000 LB
COOLING WATER PUMPS
477,000 LB
1,466,140 LB 48.0 h 75.0 F
BAL. DRUM LEAK-OFF
69,000 LB 335.9 h 361.0 F
1,920,000 LB 335.9 h 356.3 F
1,990,000 LB
0 LB
1,899,000 LB 335.9 h 361.0 F
BOILER FEED PUMPS
TO DEAERATORS NOS. 1 AND 2 IN OLD STATION
58,470 LB 77.3 h 109.5 F
BLOWDOWN HEAT EXCHANGER
DEAERATOR SUPPLY PUMPS
1,466,800 LB 67.5 h 99.3 F
8340 LB
58,470 LB 538.9 h 556.3 F
GLAND SEAL RETURNS
50,000 LB
34,000 LB 98.0 h 98.0 F
BEARING COOLING WATER RETURNS
1,495,140 LB 57.9 h 89.3 F
506,000 LB 88.2 h 117.2 F
989,140 LB

tion to be maintained at a much higher level. Final blowdown is from the secondary section where the continuous blowdown from the primary section is concentrated. The overall result is low concentration in the most active section of the boiler with a final blowdown of negligible proportions.

Here we have at least one instance where the refinery engineers have been leaders and not followers of the utilities. The dual-circulation boiler was conceived by its inventor strictly as a means of reducing blowdown losses and improving furnace tube conditions in industrial boiler plants, using very high percentages of treated make-up for boiler feed water. Stanolind Station No. 3 was the first power plant to use the design. However, the steam produced in the dual-circulation boiler was found to be exceptionally pure. Solids carried over in steam from boiler drums to the superheaters and turbines may cause overheating of superheater tubes and fouling of turbine blades, with consequent loss of capacity. Dual circulation has, therefore, come into use for utility operations where the boiler feed is substantially 100% condensate. A reheat boiler of the dual-circulation design has recently been placed in operation at East River station of Consolidated Edison Co. in New York City. The boiler is among the largest in operation, producing 1,450,000 lb of steam per hour at 2,075 psi and 1,000°F, with reheat also at 1,000°F.

In dealing with steam generation in the refinery, the remarkable developments of Sinclair Refining Co. for recovery of heat in the waste gases from refining processes should not be overlooked. In conjunction with a catalytic cracking unit built at its refinery in Houston, Texas, a carbon monoxide boiler was installed to recover part of the sensible heat in the exit flue gases leaving the regenerator, to recover all of the heat of combustion of the carbon monoxide and to preclude the possibility of other gaseous air pollutants being emitted to the atmosphere.

The carbon monoxide boiler was designed to produce 340,000 lb per hour of saturated steam at 700 psi when fired with full production of carbon monoxide bearing gas from the regenerator and 220,000 lb per hour when fired by refinery gas and oil only. The boiler consists essentially of a primary cylindrical refractory furnace for burning the carbon monoxide gas, a secondary water cooled furnace and an economizer. Fig. 9 illustrates the general arrangement of the boiler. Injection of the carbon monoxide gas into the primary furnace is through 12 tangential inlet ports evenly located around the primary furnace with four ports on each of three levels. Twelve auxiliary fuel burners are similarly arranged with the top row located above the top row of the carbon monoxide ports so that the carbon monoxide bearing gas would have to pass through a layer of auxiliary fire before leaving the primary furnace.

The carbon monoxide boiler generates enough high pressure, high temperature steam to drive all of the prime movers for its companion fluid catalytic cracking unit by means of condensing turbines, thus reducing the load on the refinery fuel fired boilers.

Another unique development in waste heat boilers is the installation by the Sun Oil Co. in connection with two large Houdriflow catalytic crackers, one at its Toledo, Ohio, refinery and one at its Marcus Hook, Pa., refinery. In this unit, a special oxidation catalyst oxidizes 900°F carbon monoxide and hydrocarbon oil vapors from the catalytic cracker exhaust, producing a clean effluent. The release of heat energy from the oxidation process raises the gas temperature to 1,500°F, after which it passes through a conventional water tube boiler producing steam for the catalytic cracking process.

A combined plant owned and managed by a public utility has one definite advantage over privately owned refinery plants, and that is the opportunity to use much larger generators. The thermal efficiency of the Whiting plant in Btu per kilowatthour is substantially the same as in the higher pressure and higher temperature Linden station, but the yield per unit of process steam is less, and the low fuel cost is offset to some extent by higher capital charges and labor costs resulting from a multiplicity of small turbine generators. The advantages over the 10,000 kw units at Whiting, which

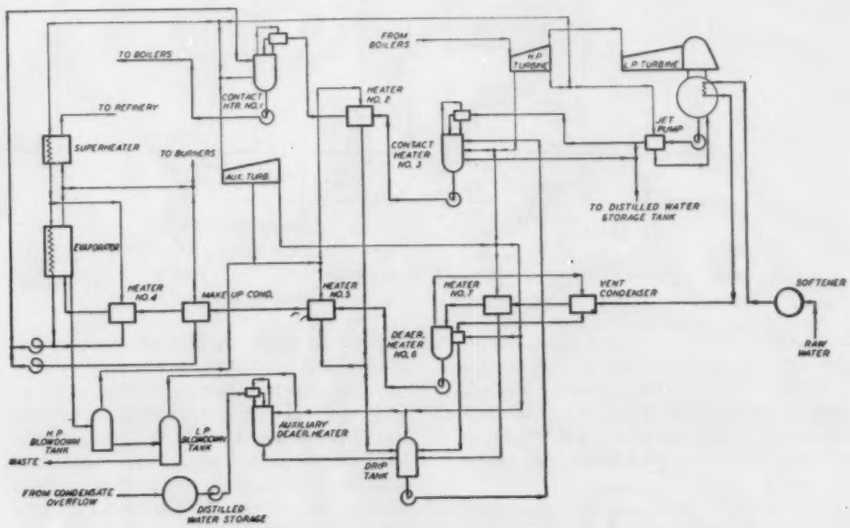
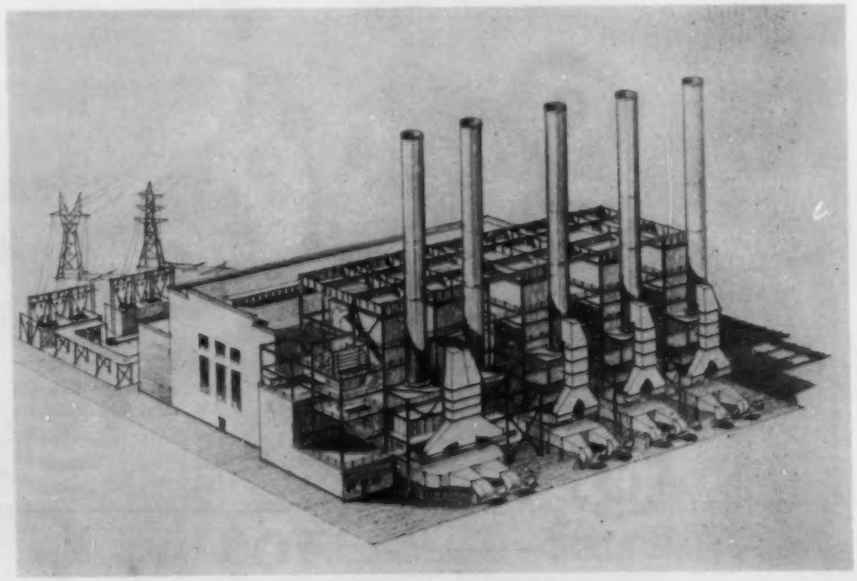


FIG. 6. *Flow diagram, Avon power plant, Pacific Gas and Electric Co., Avon, Calif.*

FIG. 7. *Linden station, Public Service Electric and Gas Co. Two 225,000 kw units will supply steam to Bayway refinery of Esso Standard Oil Co. and power to the utility system.*



accrue from the 50,000 kw Pacific Gas and Electric Co. units, the 55,000 kw Gulf States units, and the 225,000 kw Public Service units, are readily apparent. Where there is an opportunity for a combined plant of the type pioneered at Baton Rouge, it should provide the lowest cost for steam and power available in the territory where the refinery is located. However, when the refinery is isolated, as in many foreign countries, or when, for other reasons, the combination with a public utility can not be made, the refineries themselves should take greater advantage of the situation inherent in their operations, using the largest practicable generators and sufficiently high pressures and temperatures to eliminate the need for condensing power generation.

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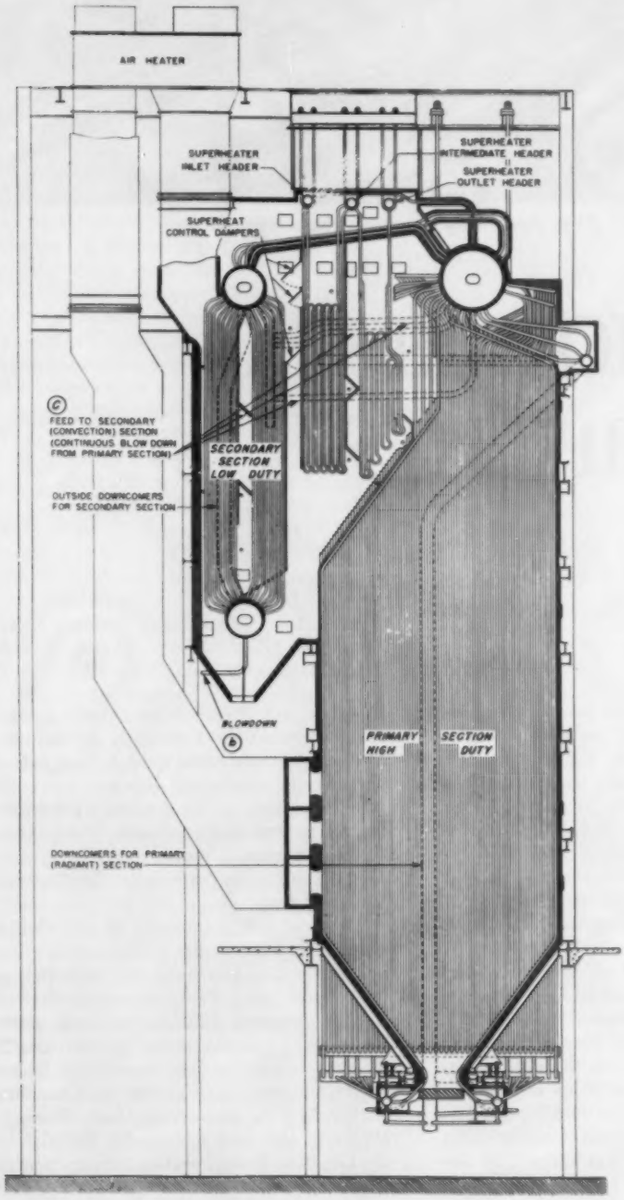
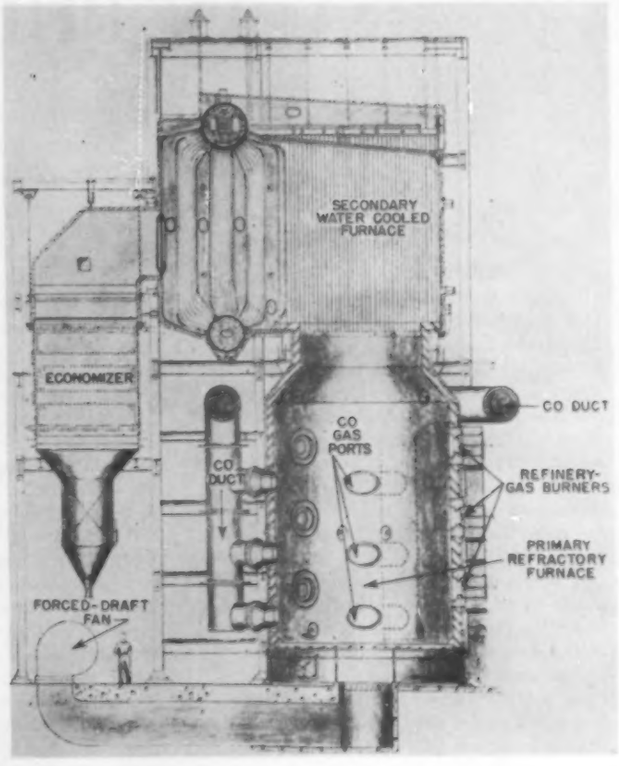


FIG. 8. *Cross section, dual circulation steam generator, Stanolind Station No. 3—Whiting refinery Standard Oil Co. (Indiana).*

FIG. 9. *General arrangement, carbon monoxide boiler, Sinclair Refining Co.*



All oil now consumed in the Philippines must be imported. Photo shows Caltex tanker unloading at Batangas Bay.

EXPLORATION RISING IN PHILIPPINES

An important exploratory well is drilling in the Philippines. Lively interest is being shown by majors and independents alike in this nearly untouched area.

SETTLEMENT of recent controversies over concession rights and the entry of new companies into the Philippines has stimulated the search for oil in the archipelago. A total of 3.6 million acres now are under exploration concession to independents as well as major companies. The concessions are widely spread in some 26 separate areas.

Desultory efforts to find oil in the Philippines have been made by various interests for more than 30 years. The present campaign is the first major effort by the industry. It parallels similar exploratory programs in all parts of the world where favorable sedimentary deposits exist, as part of the campaign to build crude reserves.

Companies which have explored previously include Richmond Oil Co., which held leases and drilled four wells on the Bondoc Peninsula during 1921-1925, and Smith Bell and Co., which held some leases about 1926. These early efforts included the drilling of shallow wells in Cebu to a maximum of 1,032 feet and one deeper well by the National Development Co. in Barili. No oil shows were reported. The law, however, provides for an overriding royalty to the discoverer of petroleum and as a result some 99 "discoveries" had been reported by the end of 1953 from numerous oil seepages in the archipelago.

During the 1930's and the early post World War II period the lack of adequate and satisfactory petroleum legislation held back development. The government had experimented repeatedly with development by public means, but without satisfactory result. In 1947 a joint resolution by the first Congress of the new republic authorized a commission to study the situation and devise a satisfactory law. In 1949 the present Republic Act 387 of June 18, was passed. It is known as the Petroleum Act of 1949. This is generally considered by the industry to be a satisfactory law and under its provisions interest has gradually awakened in the several large, undrilled structures which are readily visible in various parts of the Philippines, especially the Cagayan Valley of Luzon.

The most active company in the Philippines at present is the Philippine Oil Development Co., known as PODCO. This is one of the many Philippine enterprises of Col. A. Soriano. PODCO has held many leases over various areas in the past. It drilled one well to 8,000 feet in the Daan-Bantayan area during 1940 and another during 1947 to about 9,955 feet. There is presently one well drilling by PODCO in the Cagayan Valley, part of the expenses of which are being contributed by Caltex. It

is located on the Tumauini anticline, in Isabela Province.

A total of about 3,583,591.8 acres of concession rights were granted during 1955, including:

Concessionaire	*No. of Concession*	*Area in Acres*
Standard-Vacuum Oil Co.	8	959,246.7
Philippine Oil Development Co.	10	1,258,151.0
Acoje Mining Co.	1	133,627.0
Caltex (Philippines) Inc.	7	1,232,589.1

These, and the two exploration concessions previously granted to the Luzon Stevedoring Co. and PODCO covering 237,505 acres, brought acreage under exploration operations during 1955 to a total of more than 3.7 million acres.

Among the other companies showing interest in the Philippines are Richfield Petroleum Co. and Cities Service Co., White Eagle Oil Co. of Tulsa and Tidewater Associated Oil Co. Standard-Vacuum's concessions were the culmination of efforts begun during 1938 to obtain exploration rights. The other companies represented, while having their domiciles locally, are also U.S. companies. Caltex (Philippines) Inc., upon acquiring its concessions, immediately transferred them to the Texaco Overseas Petroleum Co. (formerly the Texas Persian Gulf Corp and a subsidiary of The Texas Co.) and California Asiatic Oil Co. (formerly Iran Oil Sales Co. and a subsidiary of Standard Oil Co. of Calif.), in a 50-50 joint interest. Applications for about 2,200,000 acres of exploration areas in Mindanao are still pending, but concessions therefor will likely be granted in 1956.

Reconnaissance surveys are resumed by fieldmen of the Philippine Bureau of Mines, and cover an area of 247,000 acres in Davao, Island of Mindanao, and about 50,000 acres in the province of Pangasinan, Central Luzon. Five oil seepages were verified in Bontoc, Mt. Province, near the Cagayan Valley area. Paleontologists of the Bureau also made statigraphic studies of sections of Northern Davao, Central Cebu and Central Iloilo. Some diamond drilling was done by Acoje Mining Co. in its concession in southern Cebu Island.

The Caltex refinery in Batangas, the only one in the country, has a crude capacity of 13,000 b/d. Crude imports for the past year amounted to 4,929,880 barrels. Refined products of the refinery were valued at about 95 million pesos. The plant employed an average of 604 men, excluding the merchandising force. The Shell Co. and the Standard-Vacuum Oil Co. have announced plans to build their oil refineries, which likewise will use imported crude.

The Philippine government is very much interested in this industrialization program because of the benefits it will bring to the country should petroleum production be realized. For the last three years, the country imported petroleum products valued yearly at an average of about $55.5 million, as follows:

1953	—	$54,344,848.08
1954	—	$57,361,769.00
1955	—	$55,543,298.91 (Estimated)

A 50-ton Diesel engine is hauled along a company built road in the Sumatran Development of Caltex Pacific Oil Co. (Photo courtesy of California Texas Oil Co. Ltd.)

Exploration and Production in INDONESIA

Despite political unrest and uncertainty, operations have gone ahead in Indonesia. Production increased 7.4% to about 234,000 b/d during 1955. Reserves rose to 2.3 billion barrels. Exploration is active except in North Sumatra and Central Java where the fate of Shell's and Standard Vacuum's properties remains undecided. Large development programs are underway by Standard Vacuum and Caltex and one has been offered by Shell.

INDONESIAN exploration is going forward, despite the troubles which have plagued the three main operators, Caltex, Shell and Standard-Vacuum. Following the establishment of the independent Republic of Indonesia, exploration rights of the companies were placed in moratorium, while Shell and Standard-Vacuum were excluded entirely from their holdings and fields in north Sumatra and central Java. The moratorium was imposed pending the passage of a new mining law, which is expected to include a special section for petroleum. It will replace the old mining code of about 1890 with its numerous amendments, which is the governing legislation today. Meanwhile, the delay in receiving new concession areas and high taxation rates have prevented the large post-war increase found in other major producing areas of the world. The nationalization has restricted development to central and south Sumatra, further limiting production.

At present operations may be conducted under four types of petroleum rights. The first of these is the prospecting permit, which carries rights to reconnaissance and stratigraphic drilling. The second stage is the "Five A" exploration concession, known after its position in Section Five A of the 1890 mining code. This right has a six-year duration. It may be followed by the "Five A" exploitation concession, which has a 40-year term. There are also some mining concessions held, obtained many years ago under the mining code, which have a 75-year duration.

Although all these rights are now in "moratorium," exploration and production thereunder are permitted. As a consequence, exploration has been actively pushed by the companies within the limits of their concessions and permits. Caltex has one seismic party and several surface parties working in its areas of central Sumatra. The company's position stems from reconnaissance work as far back as 1924 by Standard of California followed up by active exploration until World War II. During that period the Minas field was mapped. It was drilled when Caltex got back in after the establishment of the Republic in 1949 and began commercial production in 1952. Conditions were so unsettled at that time that it represented the closest field to relatively safe operating areas, but it also turned out to be the major strike in Indonesia since the war. Production is now at about 74,241 b/d. The terrain is difficult to operate in, and rather than push a pipe line 90 miles to deep water, through the jungle, Minas crude is piped to the river and loaded on special river tankers for delivery to a marine terminal. Among the smaller discoveries which have been made by the company and not yet developed are Pungut, Sabanga, Duri and Kotabatak.

Despite the uncertain political situation which it has faced, the company has made substantial investment in the area. The company has already heavily invested, but has faith in the Indonesian government's eventual recognition of the importance of an active petroleum industry.

Standard-Vacuum, which operates in south and central Sumatra, has been hard hit, with the nationalization of its properties in north Sumatra. It is going ahead, however, with a $80 million development plan for completion by 1958.

TABLE I

STANDARD VACUUM'S FIELD PRODUCTION

Field	1955 Production (b/d)
South Sumatra	
Talang Akar-Pendopo	40,183
Djirak	38,706
Kruh	135
Benakat	15,525
Radja	3,722
Betun	1,090
Abab	523
Central Sumatra	
Sago	754
Lirik	21
Ukui	12
South Pulai	9
TOTAL	**100,680**

The plan includes modernization of the company's 71,000 b/d Sungei-Gerong refinery with addition of catalytic cracking and catalytic polymerization plants. A modern office building is also planned at Palembang.

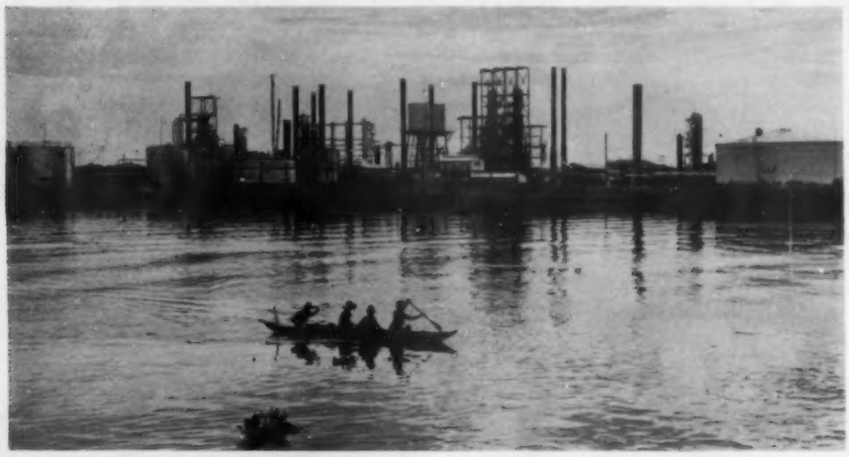
Another facet of the modernization program is construction of a 90-mile pipe line from the Lirik field of central Sumatra. There Standard-Vacuum faces an unusual problem in transportation of Lirik crude. The field, which was discovered in 1939, produces a waxy crude with very high pour point of 105° F. Its value as a refining stock is obvious, but it raises severe transportation difficulties because of its pour point. The Japanese, who took the field over during World War II, tried to build a pipe line,

but the crude froze in the line when its heating system broke down. They then poured it into wicker baskets in the nearby Indragiri River and and floated it downstream.

Standard-Vacuum's engineers are constructing a $8.5 million pipe line with heating stations every 18 miles to keep the crude flowing. Hot water is being circulated in the upper one-third of the well casing to prevent solidifying during production. The pipe line is scheduled for completion in 1958 and will have about 20,000 b/d capacity. Meanwhile, about 2,000 b/d is being run through a six-inch line to Djapura, on the Indragiri River, where it is put into barges equipped with heating coils and loaded on ocean-going tankers at Tjenako.

TABLE II

Field	June 1955 Production (b/d)	Year Discovered	API Gravity	Age of Producing Formation
Kalimantan (Formerly Dutch Borneo)				
Tandjung	24	1938	38.5	Eocene
Tarakan	4,330	1906	18.3	Pliocene
Bunju	7,659	1930	32.4-24.4	Pliocene
Samarinda Fields				
Sanga Sanga	3,070	1897	19.5-32.1	Miocene
Anggana-Muara	2,015	1902	19.5-32.1	Miocene
Sangatta	-c-	1940	36.0	Miocene
Sambodja	900	1910	23.3-31.2	Miocene
North Sumatra				
Perlak, Dj. Rajeu, Gebang, Telaga Said Darat, Pangkalan Susu, Rantau, Serang Djaj and P. Tabuhan fields are being held by the government. There is no production at this time, except small amounts for government use.				
South Sumatra				
Palembang Fields				
Mangundjaje	1,990	1935	24.5	Pliocene
Prabumulih-West	3,180	1953	31.3	Miocene
Limau	15,900	1926	31.1	Miocene
Talang Djimar	20,915	1937	28.8	Miocene
Gunung Kemala	6,010	1938	35.6	Miocene
Tandjung	4,105	1940	27.6	Miocene
Suban Djerigi	400	1905	49.9	Pliocene & Miocene
Muara Enim Complex (Satu Kras, Sei Taham)	20	1903	49.9	Pliocene
Djambi Fields				
Badjubang	2,590	1927	46.9	Miocene
Kenali Asam	15,380	1931	24.3-44.8	Miocene
Tempino	7,625	1931	46.2	Miocene
	96,116			



Boat loaded with workers heads toward the dock of the refinery at Sungei-Gerong, Sumatra. Many of the refinery workers come to work in their own boats. B.P.M.'s Pladju refinery in background.

Part of an oilfield in Java. (Photo courtesy of Shell Refining and Marketing Co. Ltd.)

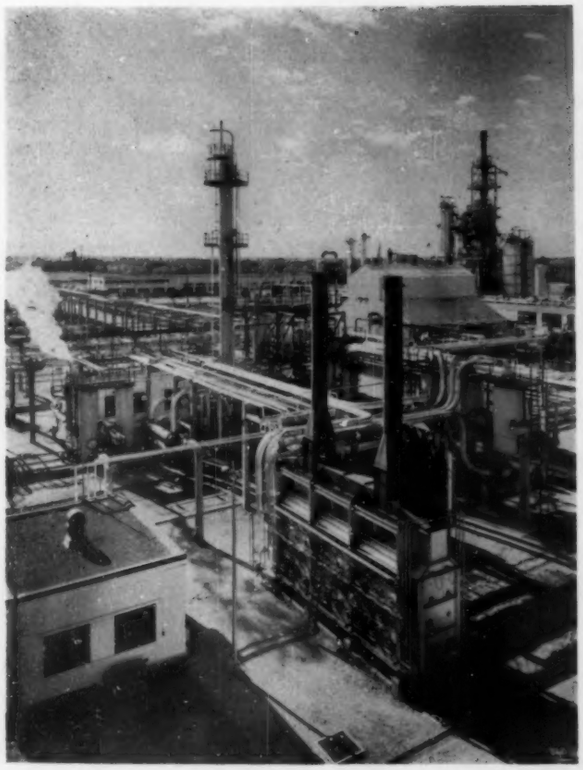
The third company in Indonesia is N.V. de Baatfsche Petroleum Maatschappij, a member of the Royal Dutch/Shell Group. Shell operates in south Sumatra, Borneo and Java. As previously mentioned, the question of Shell's properties in north Sumatra remains unsettled. In April 1955 M. J. Bolderdijk, a director, disclosed plans to increase Shell's investment in Indonesia by about $400 million during the next ten years. As conditions of the investment he listed the return of the north Sumatra and Java fields, guaranteed maintenance of law and order, and institution of the 50-50 profits split, the latter because the existing division of profits in the country is considerably less favorable than 50-50.

Shell is the major producer in Indonesia, with about 96,000 b/d production during June 1955. Shell's active producing fields are given in table II.

A major consideration in Indonesia has been the taxation problem. The level of income taxation in Indonesia is high, as are the import duties and internal excise taxes. Income taxes range from 40% on about $43,850 to 52½% on profits over $219,250. Deductions are permitted for depreciation and new capital expenditure, including allowance of anticipated capital expenditure as depreciation in the current tax year. Dividends are subject to a new 66⅔% remittance tax on exchange transfers. A recent development is the imposition of a 40% compulsory profits retention tax. This definitely applies to marketing oil companies, but its application to producers is not yet defined.

Within Indonesia the level of customs duties is exceptionally high, especially on imports of automobiles. The price of gasoline has recently been increased by an additional rise in the excise duty, raising the price from 16.5 cents per gallon to 39.5 cents per gallon in the spring of 1955.

The effect of increased taxation has been to make it difficult for Indonesian petroleum to remain competitive. The problem is fundamentally one of education of the responsible government officials to the value and problems of the petroleum industry. How effective the companies may have been in this direction remains to be seen. Some indication may be received when the new petroleum law has been promulgated—and especially when the issue of Shell's and Standard-Vacuum's confiscated properties has been settled.



Powerforming unit at Edmonton, Alberta, refinery of Imperial Oil Ltd.

ESSO RESEARCH DEVELOPS NEW PLATINUM PROCESS

ESSO Research and Engineering Corp. has announced development to the commercial stage of its version of catalytic reforming." It is the sixth platinum process to The Esso process has been named "Powerforming." It is the sixth platinum process to be announced as available to the industry.

Three Powerformers now are in operation and affiliates of Standard Oil Co. (N.J.) are building 13 additional units which will cost an aggregate of $60 million. Capacities of the various plants will range from 1,000 to 26,000 barrels daily.

The three operating units are at the Esso Standard plant at Baltimore, Md., a 3,000 b/d plant; at the Billings, Mont., refinery of Carter Oil Co., a 2,500 b/d unit; and at the Edmonton, Alta., refinery of Imperial Oil Ltd., a 2,000 b/d Powerformer. As described in the February issue of WORLD PETROLEUM, the Edmonton unit is supplying hydrogen for treating lubricating oils produced at the Imperial refinery.

Esso Research has announced that it is offering the process to refineries in keeping with the company's general policy of licensing others.

Basic research on Powerforming was undertaken by Esso some five years ago. Pilot plant tests of the process were carried out at the Linden, N.J., laboratories. An essential part of the process is the new type catalyst which is said to give high yields of high octane reformate.

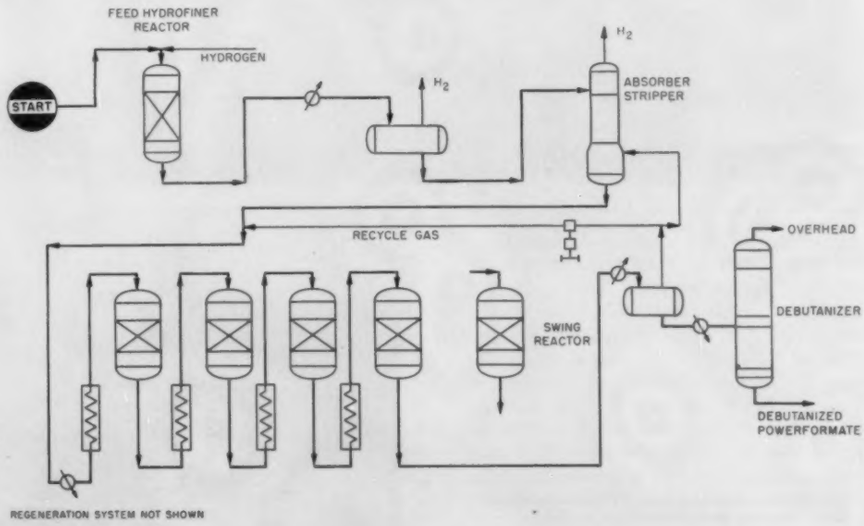
Powerforming is a fixed bed cyclic process. Its flow is somewhat similar to the Ultraforming process developed by Standard Oil Co. (Ind.) which is the only other cyclic process thus far developed to the commercial stage. It is understood that Esso has arranged for rights to certain elements in the Standard of Indiana process. Neither of the companies has revealed the technique employed in regenerating the catalyst.

Powerforming uses from four to six reactors with from three to five being on stream and one being regenerated. Typical flow is indicated in the accompanying diagram.

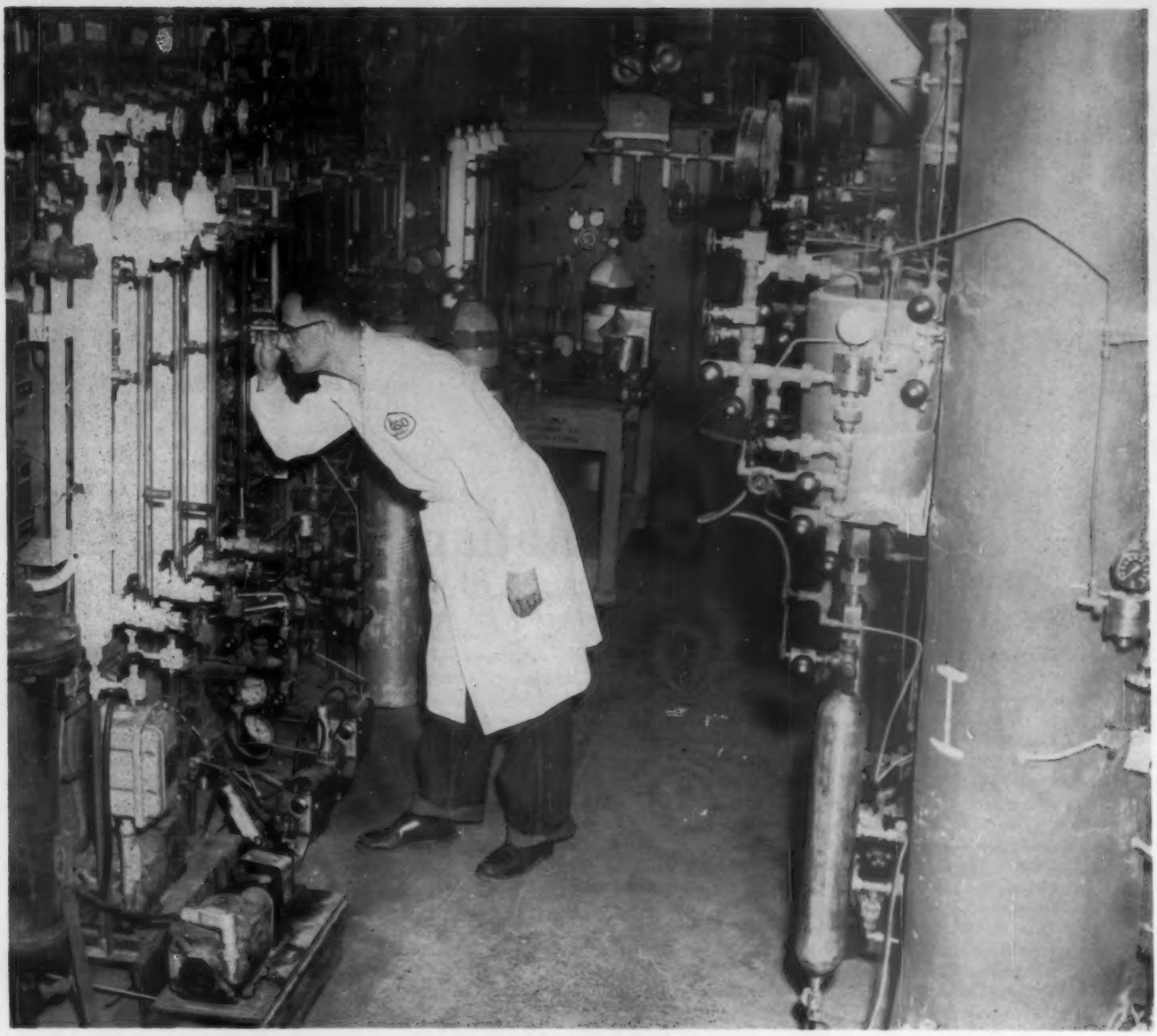
The cycle on any one reactor varies from five to 15 days. Due to the new regenerating technique, the catalyst is said to retain its high initial activity indefinitely. Excellent yields of high octane number product are claimed at high feed rates. The process also gives a high yield of hydrogen.

Typical feeds consist of a low-octane virgin naphtha or a cracked naphtha-virgin blend. Excellent results have been obtained with blends containing fluid coking naphtha. Tables 1 and 2 show inspections of various feed stocks and operating results.

Hydrofining of feed stocks is not necessary, but is generally preferred.



Flow diagram of Powerforming process.



Twelve gallon-a-day pilot plant used in development of Powerforming process.

TABLE 1

Inspections of Feed Stocks for Powerforming

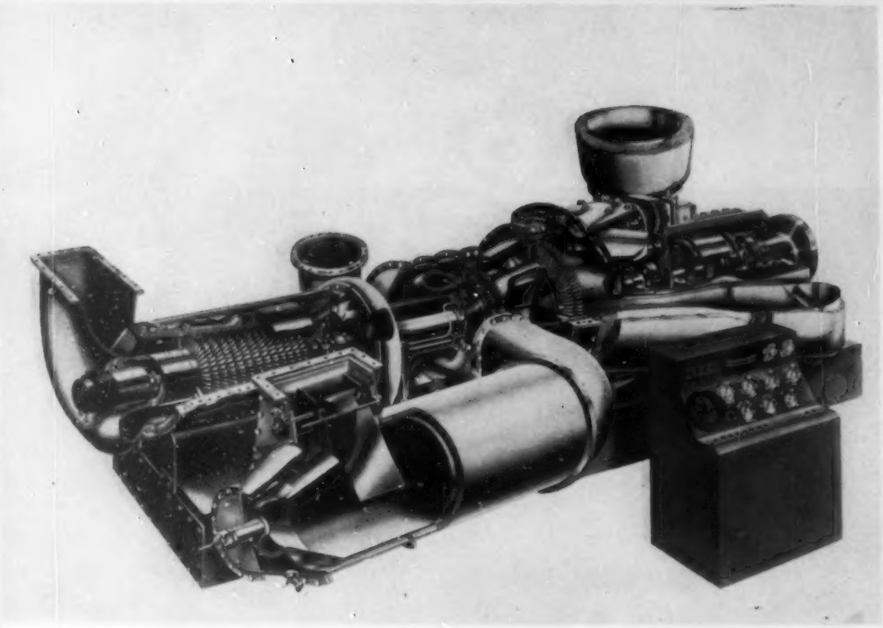
	Light Arabian	Heavy Arabian	Mixed Louisiana	Heavy W. Texas
Gravity, °API	61.9	54.0	60.3	50.6
Sulfur, wt. % *	0.03	0.07	0.005	0.20
CFR-R Octane, Clear	39	29.7	53	46.1
Distillation				
10	216	276	205	288
50	241	326	231	308
90	282	370	293	350

* Before Hydrofining

TABLE 2

Operating Results with Powerforming

Feed Stock	Light Arabian	Heavy Arabian		Mixed Louisiana	Heavy W. Texas
Research Octane, Clear	95	95	100	98	98
+ 3CC	100.5	100	103	103	102
Motor Octane, Clear	85.5	85	88.5	88	87
+ 3CC	92	91.5	93.5	93	92
Yields					
C_5+, Vol. %	72.5	77	69	72.5	81
C_4 , Vol. %	10.5	9	11.5	10.5	6.5
C_1-C_3, Wt. %	12.5	12	16.5	12	8.5
H_2 , Wt. %	1.4	1.0	0.7	1.8	1.8
H_2 , SCF/B	680	510	350	880	930



Cut-away illustration of the Ruston 'TA' gas turbine.

Azienda Generale Italiana Petroli (A.G.I.P.) has installed the first industrial gas turbine in Italy at its Cortemaggiore gasoline plant in the Po Valley. The unit now has been in operation nearly a year producing power and by-product steam.

First Gas Turbine in Italian Gasoline Plant

PRODUCTION of natural gas in the Po Valley region in Italy doubled in the two years following activation of the AGIP gasoline plant. When the plant first was built in 1952, it was designed to produce 200 tons per day of motor gasoline and 130 tons per date of LPGas from 100 million cubic feet. This was considered ample to allow for expanded production but within two years the capacity was exceeded.

In August 1954 a Ruston "TA" gas turbine was ordered to expand the plant's power and steam supply. The turbine is a simple open cycle gas turbine with free output shaft and produces under normal conditions, when running non-recuperatively, an output of some 1,200 hp.

It has a 13-stage axial flow compressor, rotating at 11,500 rpm on full load, which supplies compressed air to the combustion chamber and is directly coupled to a 2-stage compressor turbine. The hot gases from the compressor turbine are conveyed to the 2-stage power turbine which rotates at 6,000 rpm and is direct-coupled through an epicyclic reduction gear to the generator. Cooling of the turbine is effected entirely by air bled from the axial compressor and ducted to all necessary points.

In addition to power supply, the turbine is equipped with an exhaust heat boiler with an economizer to utilize the turbine exhaust heat which provides process steam for the refinery. The turbine drives a 500 volt, 50 cycle, 3 phase alternator designed and manufactured by the Compagnia Generale di Elettricita of Italy. The rating of the gas turbine alternator set with the exhaust heat boiler by-passed is 890 kw, which is reduced to 870 kw when the exhaust gases pass through the boiler, because of the back pressure of 80 mm water gauge on the gas turbine.

The boiler equipment comprises a Tosi boiler incorporating "Swirlyflow" tubes, a super heater and a Green type economizer. When operating on turbine exhaust, this installation can produce 4,200 kg of steam per hour at a working pressure of 8 kg per sq. cm. By utilizing the considerable quantity of oxygen present in the exhaust, auxiliary gas burners can be used to increase the total steam output to 9,000 kg per hour. The burners installed are of sufficient capacity to ensure that, even when the turbine is not running, the full steam output of 9,000 kg per hour can be obtained. In the latter case a separate auxiliary air supply is fed to the methane burners in the boiler.

The flexibility of the gas turbine and boiler system is further increased by the ducting arrangement which allows the turbine to exhaust direct to atmosphere without the gases passing through the boiler, or alternatively the boiler can be isolated from the turbine and be operated as an independent unit.

A neat power house arrangement is achieved by placing the ducting for the air intake and the gas exhaust of the turbine beneath floor level. The lubricating oil for the gas turbine is cooled in a compact water type cooler mounted alongside the set, again contributing to power house neatness.

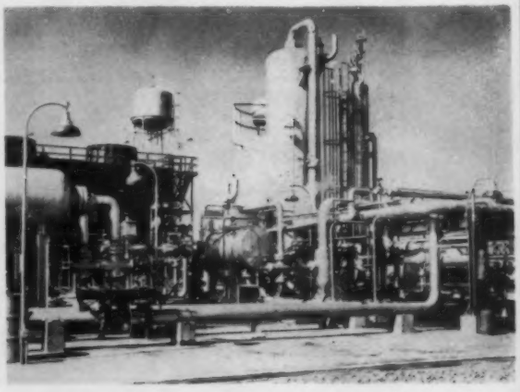
Starting of the gas turbine and control when running, is carried out on a control cubicle neatly mounted alongside the turbine and carrying all necessary pressure and temperature instruments. The starting procedure is safeguarded by interlocks incorporated in the control panel, in such a way as to ensure that the various starting processes are carried out in the correct time intervals. To facilitate frequency adjustments a remote control speed regulator is fitted on the main alternator control panel.

The starting of the set is by means of a 20 hp electric motor operating on the end of the compressor shaft. The motor is powered by a 24-volt battery of conventional design.

The turbine was ordered Aug. 4, 1954. It left the Ruston and Hornsby, Ltd. factory at Lincoln, England May 18, 1955, and arrived at the site June 2nd. It was started up for the first time June 18, 1955.

Up to the end of 1955, the set had run for over 3,000 hours on service loads, mostly in parallel with one or more of the piston gas engines. Now that the gasoline plant has settled down, it was intended to run the turbine continuously day and night seven days a week until plant overhaul some time during this month.

A section of the A.G.I.P. refinery plant at Cortemaggiore which supplies the gas to the distribution pipeline network throughout Northern Italy.



NUCLEAR PHYSICS

in petroleum exploration research

By Richard L. Caldwell[1]

IN April, 1953 the field research laboratories of the Magnolia Petroleum Company began a research program in nuclear physics with the installation of a half-million volt Van de Graaff accelerator. The advent of particle accelerators at a reasonable cost offered many new approaches in petroleum research. In particular, it became feasible to study in considerable detail the nuclear properties of earth materials. The small amount of work that had been done before this time showed that earth materials possessed a widely varying set of nuclear properties that were rich in detail. Many of the variations could be expected to have geological significance. Radioactivity well logging was already of commercial importance; also, for several years, the industry had been using radioactive tracers in engine wear studies, for following the flow of liquids, in the study of chemical reactions and for other uses. The choice of tracers for these applications was usually limited to radioactive materials of reasonably long half-life since the radioisotopes had to be shipped from an A.E.C. plant to the user.

With a positive ion accelerator one can produce controlled sources of neutrons and/or gamma-rays by selection of the type of gas used in the ion source and the target bombarded with these accelerated ions. That is, the number and energy of the neutrons and/or gamma-rays can be controlled by selection of the proper nuclear process and adjustment of the accelerator's voltage and current. The release by the U.S. Atomic Energy Commission of tritium, the heavy hydrogen isotope of mass 3, made it possible to produce a high intensity of monoenergetic 14 million-electron-volt (Mev) neutrons with a low voltage accelerator. With this reaction, using a bombarding energy of 250 kilo-volts, one readily obtains a neutron source strength of 5×10^9 neutrons/second. This is more than two hundred times the intensity of the neutron sources currently used in commercial radioactive well logging. The average energy of the neutrons from these conventional capsuled sources is about three to four million volts. Thus, the accelerator-produced neutrons from the deuterium-on-tritium reaction are of much higher energy (14 Mev) as well as higher intensity. The higher energy neutrons will penetrate much farther in common earth materials before being slowed down and absorbed. Hence, 14 Mev neutrons are of particular interest for well logging applications.

By using other nuclear reactions one can produce neutrons in the medium and low energy ranges. The deuterium-on-beryllium reaction has been particularly useful as a moderate intensity source of thermal or slow neutrons when used in conjunction with a paraffin moderator. Still other reactions, such as protons-on-fluorine and protons-on-lithium have been used as sources of gamma rays of known intensity and energy. With these reactions 6 to 7 Mev and 14 to 17½ Mev gamma-rays are produced. These are much higher energies than are available with any capsuled gamma-ray emitting radioisotope.

Richard L. Caldwell received a B.S. degree in 1939 and an M.S. degree in 1941, both in Physics from the Louisiana State University. In February 1948 he was granted an O. M. Stewart Fellowship to do his doctoral research in nuclear physics at the Argonne National Laboratory, Chicago, Illinois and received his Ph. D. degree in Physics in June 1949. In August 1949 he joined the Magnolia Petroleum Company's field research laboratories in Dallas, where he is presently a research associate and is in charge of the Nuclear Physics Research group. Memberships include American Physical Society, Phi Kappa Phi, Sigma Xi and Dallas Geophysical Society.

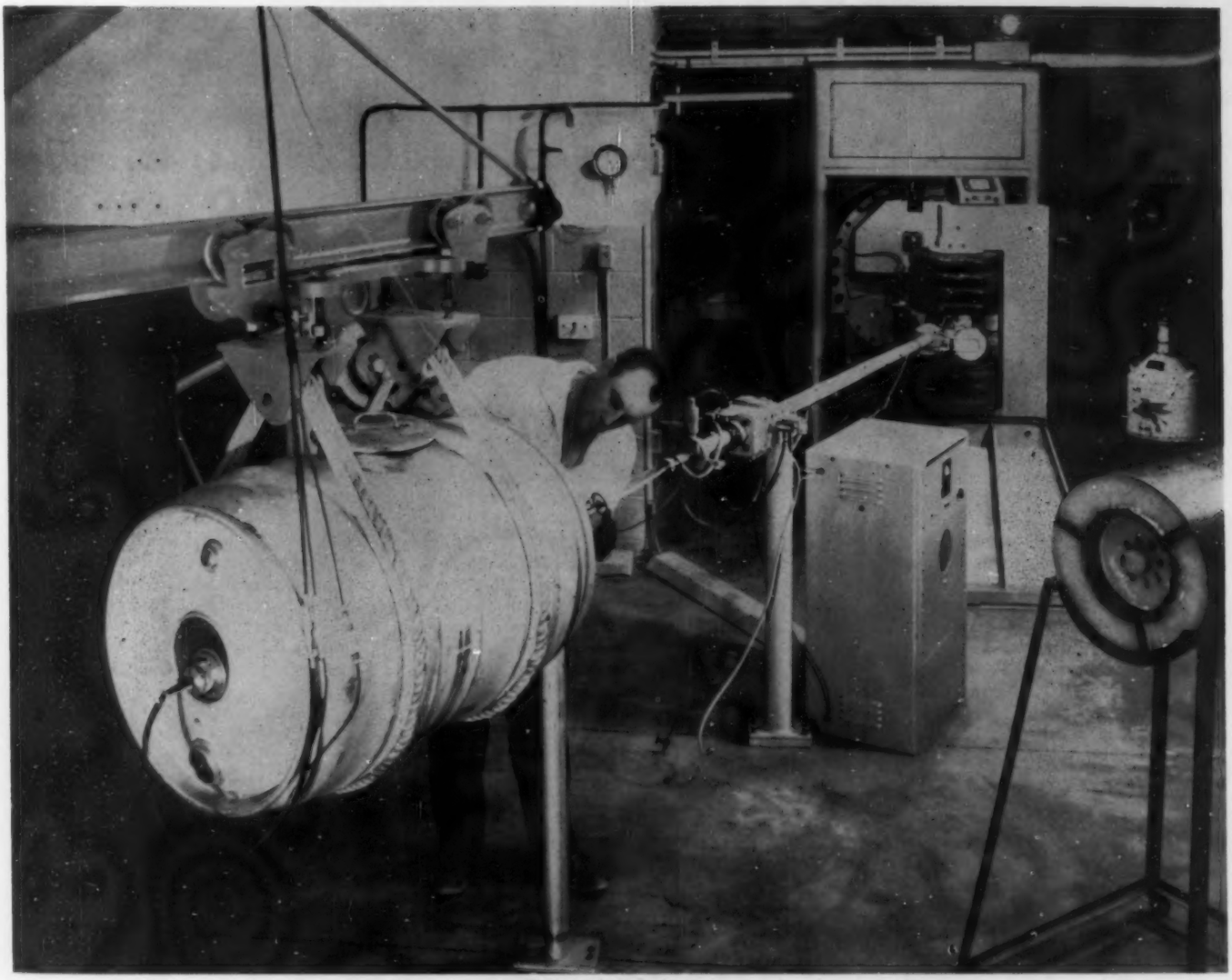
The accelerator as a source of neutrons is used principally for two areas of research: radioactive well logging and radiochemical analysis. Although radioactive well logging has been employed in an empirical manner for a number of years, little is known of the fundamental nuclear processes which are involved. A conventional neutron source used in logging, although having an average neutron energy of three to four Mev, has a neutron spectrum ranging from less than one Mev to over 10 Mev. With the accelerator as a source of neutrons, one can investigate independently various segments of the neutron spectrum of conventional neutron sources.

In addition to the well-logging studies, controlled sources of neutrons and/or gamma-rays are useful for rapid chemical analysis for certain elements in core samples, cuttings, crude oils, etc. Various elements of interest can be made radioactive selectively by proper choice of the neutron bombarding energy. Further discrimination can be made on the basis of the energy and rate of decay of the radioactivity produced by the neutron bombardment. The absorption of gamma-rays in materials depends on the density and elemental composition of the substance and on the energy of the gamma-rays. Low energy gamma-rays are particularly strongly absorbed by elements of high atomic number whereas the absorption of medium energy gamma-rays (0.5 to 1.0 Mev) in the common sedimentary materials depends almost solely on the density of the material. Thus, gamma-ray absorption is useful as a rapid method of determining the density of cores and of liquid petroleum and water.

In addition to the research which is dependent upon the accelerator as a source of nuclear radiations, the Magnolia nuclear physics program includes work with neutron and gamma-ray sources purchased from the Atomic Energy Commission. Also, a carbon-14 radioactive dating facility has been in operation for two years for measuring the age of recent geologic samples from 100 to 35,000 years old.

Description of Facilities—In figure 1 is shown a diagrammatic sketch of the accelerator, which consists of a high voltage electrostatic generator, ion source within the high voltage terminal, acceleration tube, magnetic beam analyzer, voltage stabilizer control, and target. The accelerator is

[1]*Magnolia Petroleum Co., Field Research Laboratories, Dallas, Texas.*



Photograph of accelerator.

mounted horizontally and the beam of the charged particles from the accelerating tube passes through the magnetic field of the analyzer which deflects the beam 25 degrees. The ions are then allowed to pass through a slit formed by two insulated plates in a voltage stabilizer control system. As the beam strikes either of the plates, an electrical signal is derived to stabilize the high voltage by means of a feedback amplifier controlling the corona loading current drawn from the high voltage terminal. The analyzer and voltage stabilizer system make it possible to control very accurately the energy of the beam which strikes the target at the end of the deflection tube. This target is then the neutron or gamma-ray source for all the experiments with the accelerator.

Figure 2 is a plan view of the building especially constructed to house the accelerator. The building is one-story and 69 feet long by 24 feet wide. In order to remove as much mass as possible from the target vicinity, the target and beam tube project over an eight foot deep pit. The pit is covered with a floor of ¼-inch aluminum supported by aluminum columns and I-beams. Aluminum is used to minimize neutron scattering. The accelerator console and laboratory area are shielded by a solid concrete wall three feet thick. This wall is nine feet high and the ceiling of the building 11 feet. A mirror placed on the ceiling allows observation of the entire accelerator room from the console area. The flat roof of the building is of very light construction and there is effectively no scattering of neutrons into the shielded area. The concrete shielding wall also serves for the anchoring of two booms which are used to position large quantities of scattering materials around the target of the accelerator. Figure 3 is a photograph of the accelerator with an aluminum barrel of scattering material placed over the target. The outside walls of the accelerator room are constructed of solid 6-inch thick concrete blocks with a brick veneer. A fence six feet high surrounds the accelerator room portion of the building. Radiation levels outside of this fence are below tolerance at all times. There is ample room behind the pressurized tank of the accelerator to permit the rolling of the tank cover and dolly during servicing operations. Tanks of nitrogen and carbon-dioxide, used to supply insulating gas for the accelerator, are stored outside of the building and the manifold pipes are accessible from inside the building near the accelerator tank.

Two area monitors for health protection are used to meet the special needs of detecting fast and slow neutrons as well as beta-gamma radiation. The first of these is a door lock monitor consisting of a fast neutron detector and alarm system for locking the entrance door to the acceleator room when neutrons are being made. A simple, rugged detector of long counting life and relatively low sensitivity was accomplished by using a stainless steel cathode Geiger-Mueller tube. Neutrons are counted by ionization of the tube gas by recoil particles from neutron bombardment of the cathode material. The G-M tube, mounted two feet from the target, feeds into a commercial count-rate meter whose output drives a relay that closes the door lock. The count-rate meter

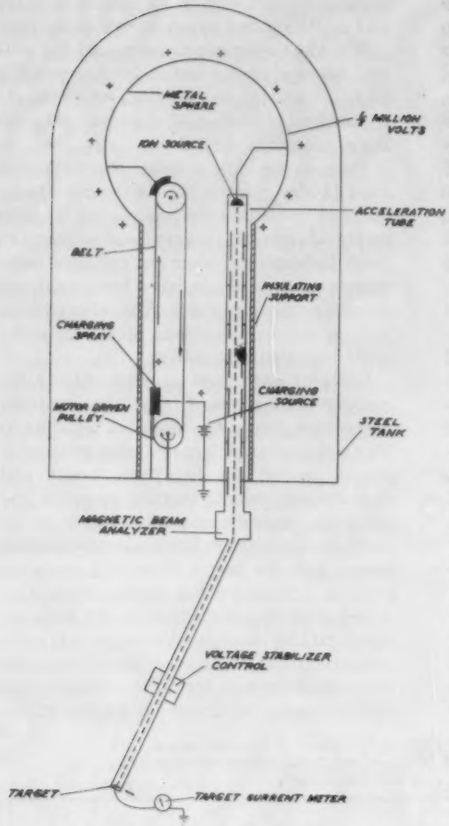


FIG. 1. *Diagrammatic sketch of Van de Graaf electrostatic generator equipped with a linear accelerating tube and magnetic beam analyzer.*

is also tied into a warning light system in the accelerator room and on a panel at the entrance door to the accelerator room. Yellow lights come on when accelerator power is turned on but neutrons are not being made. When neutron production begins, the yellow lights go out and red lights come on. If the accelerator room door is open, a loud buzzer sounds until the door is closed. Upon closing the door it is locked and cannot be opened from the outside. (An operator inside the accelerator room can get out through the door.)

The second area monitor measures and records the radiation level in the working area outside the accelerator room. The monitor consists of a commercial ionization chamber that is sensitive to neutrons, gamma-rays and beta-rays. The monitor output is connected to a strip-chart pen and ink recorder that makes a permanent record of the radiation level.

In addition to the health protection monitors, two "long counters" are employed for quantitative neutron measurements, as well as various scintillation spectrometers for gamma-ray measurements.

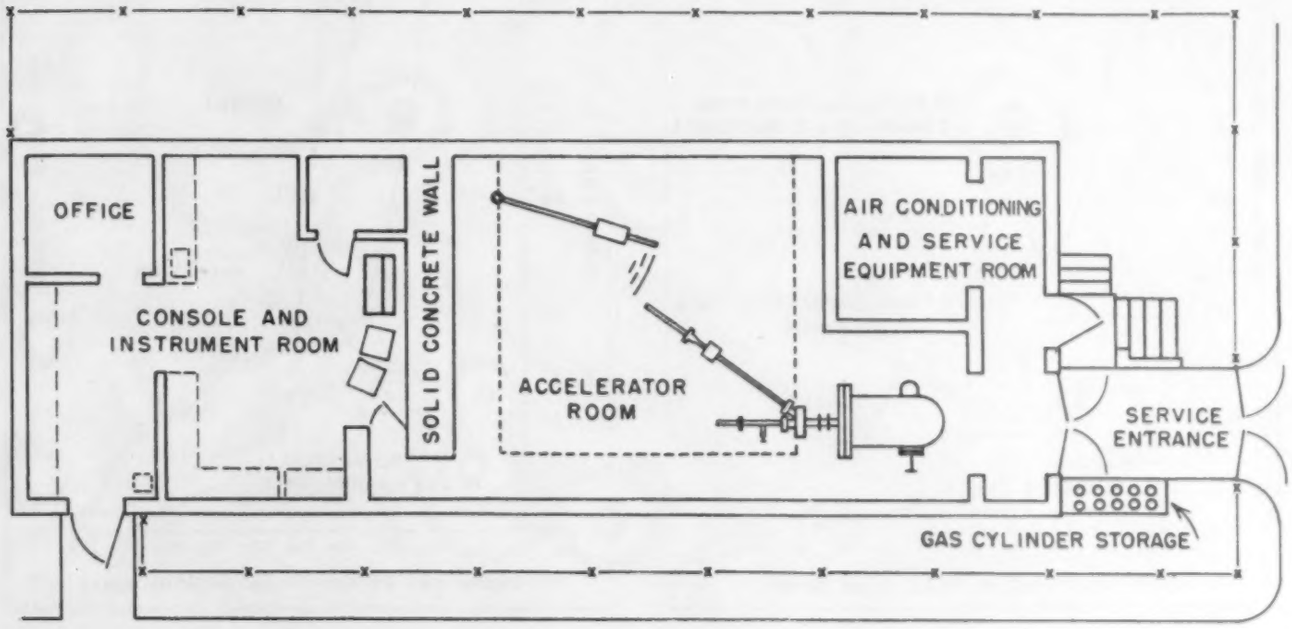
Research with 14 Mev neutrons. The deuterium-on-tritium reaction produces 14 Mev neutrons and no gamma rays. Bombardment of common earth materials with these neutrons produces *prompt radiation* emitted only during the bombardment and *delayed radiation* (or *induced radioactivity*) which continues to be emitted after the end of the neutron bombardment. A significant part of both of these radiations is gamma-rays with energies ranging from less than one Mev to about 10 Mev. Neutrons of initial energy 14 Mev incident on a given material will, in general, undergo a number of collisions before being absorbed. The first collision will usually be an inelastic scattering with the neutron losing much of its energy to the target nucleus. The scattering nucleus is left excited and may emit one or more prompt gamma-rays to return to its stable ground state. Approximately 10 per cent of the initial collisions of 14 Mev neutrons are of the absorption type in which the neutron disappears completely and a nucleus of a different element is formed by emission of a charged particle or two neutrons. The new nucleus remaining then emits delayed radiation, some of which is gamma-rays. The delayed radiation is characterized by its time rate of decay, or half-life, and its energy. By using a scintillation crystal detector one can measure the energy as well as the number of both the prompt and delayed gamma-rays.

After a 14 Mev neutron has made an initial inelastic scattering it is usually left with an energy of about one Mev or less. The second neutron collision and many succeeding ones are of the elastic type in which some of the neutron energy is lost (with no gamma-radiation produced) until the neutron is slowed down to thermal energy. Hydrogen has a large elastic scattering cross-section and hence, if present, is particularly effective in slowing neutrons. When the neutron has been slowed to the thermal energy region, it is captured or absorbed by a nucleus. The absorption process frequently produces a prompt gamma-ray and leaves a residual nucleus that emits one or more delayed gamma-rays, again with characteristic energy and half-life.

Thus, 14 Mev neutrons can produce prompt and delayed gamma-rays in their initial collisions with nuclei. Then, when the neutrons have been slowed to thermal energies (this process requires only a very small fraction of a second but a path length of perhaps as much as a few feet of earth materials), another set of prompt and delayed gamma-rays is produced.

Prompt Gamma-rays. An investigation was made of the gamma-rays produced during fast neutron bombardment of the elements commonly found in sedimentary

FIG. 2. *Plan of accelerator building.*



rocks and in their contained fluids. In figure 4, the results are given for two of these elements, carbon and oxygen. Each curve has one prominent peak, due to 4.5 Mev gamma-rays from carbon and six to seven Mev gamma-rays from oxygen, respectively. Figures 5 and 6 show curves for aluminum, silicon, magnesium, calcium, and iron. These are typical of the principal elements in sedimentary rocks in that no strong peaks in the energy range three to 10 Mev are observed in the gamma-ray spectra. The other elements investigated were hydrogen, fluorine, nitrogen, titanium, chlorine, phosphorus, sulfur, sodium and potassium. (The curves for hydrogen and sulfur show weak peaks at 2.2 and 2.3 Mev, respectively.) These data suggest the basis for a radioactive method of analysis for the elements carbon, hydrogen, oxygen and possibly sulfur on the basis of the prompt gamma-rays produced by bombardment with 14 Mev neutrons. With the recent announcements by service companies of the development of borehole accelerators for the production of 14 Mev neutrons it now appears possible to make a radioactive log that should distinguish directly between oil and water.

Delayed Gamma-Rays. Measurements were made of the delayed gamma-rays resulting from 14 Mev neutron bombardment of pure elements, rock samples from the National Bureau of Standards, and outcrop samples. In this study precautions were taken to insure that the activity observed was due entirely to fast neutron reactions. A small sample was placed adjacent to the neutron source with no large scattering materials nearby. The sample was bombarded for a few minutes and the gamma-rays were observed for about one hour after the end of bombardment. Figure 7 shows the relative activities observed per gram of pure material. The start of counting for these curves was one minute after the end of bombardment. The rate of decay and energy of the gamma-rays shows that the principal radioisotope produced is aluminum-28, which is formed from either silicon or phosphorus. Since phosphorus is not commonly abundant in sedimentary rocks, the principal activity is obviously due to silicon. Figure 8 gives the decay curves for several typical outcrop samples; here it can be seen that sandstone gives a much higher activity a few minutes after the end of bombardment than does shale or limestone.

When the counting of the delayed radiation is begun immediately after the end of bombardment, a high intensity short-lived activity is observed from chemical compounds or rocks containing oxygen. This activity decays with a 7.5 second half-life and emits six and seven Mev gamma-rays.

When the counting is continued for several hours after the end of bombardment, a 15-hour activity is observed which is attributed to activation of aluminum to form the radioisotope sodium-24.

Thus, on the basis of delayed gamma-rays from 14 Mev neutron bombardment of sedimentary rocks one can analyze for the elements aluminum, oxygen and silicon. In these Laboratories over six hundred samples of various kinds have been analyzed for one or more of these three elements, as well as for certain other elements, using radioactivation methods.

Research with slow neutrons. Using the reaction deuterium-on-beryllium, neutrons of medium energy are produced with the ½ Mev accelerator. A large paraffin moderator placed around the beryllium target will slow the neutrons to thermal energies. For activation experiments the sample to be analyzed is placed in the moderator several inches from the target. Since only neutrons produce activation, the gamma-rays produced from the beryllium target have no effect on the sample. Activation of sedimentary rocks with the slow neutrons available from a ½ Mev accelerator is primarily due to the aluminum content of the

FIG. 4. *Differential count of prompt gamma-rays from 14 Mev. neutron bombardment of carbon and oxygen.*

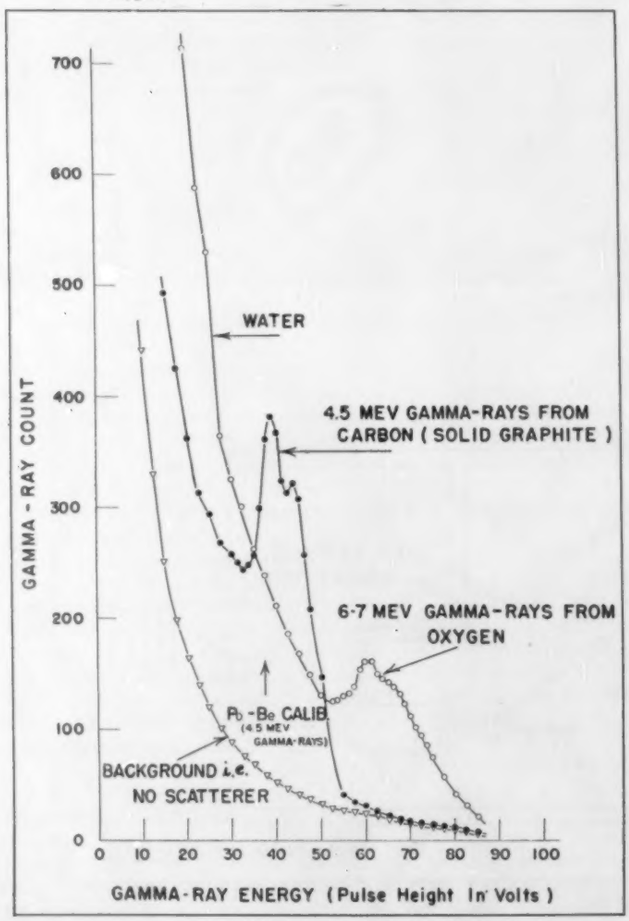
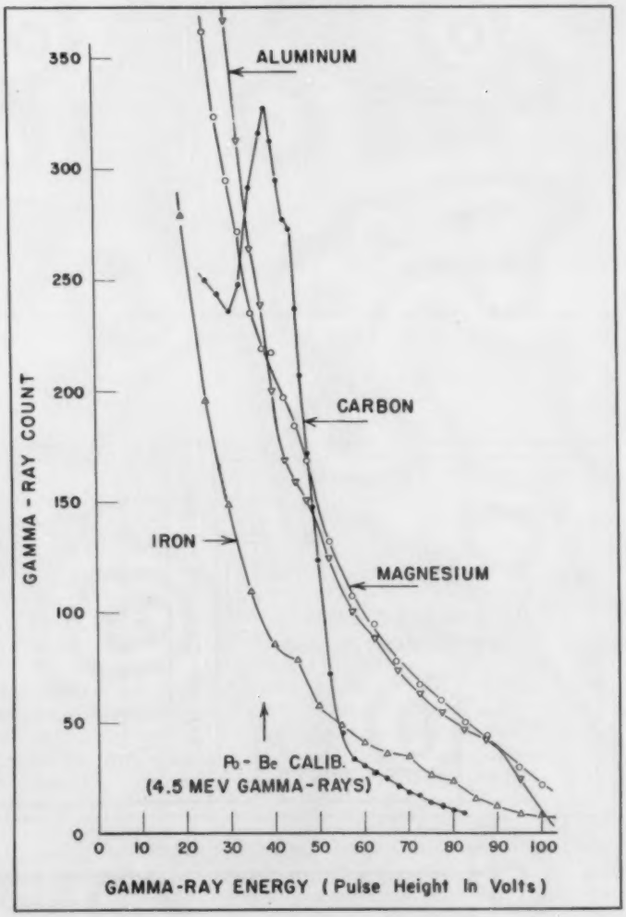


FIG. 5. *Differential count of prompt gamma-rays from 14 Mev. neutron bombardment of aluminum, carbon, iron and magnesium.*



sample. In figure 9 is shown the decay curves for several outcrop samples bombarded with slow neutrons.

A conventional capsuled neutron source (radium-beryllium or polonium-beryllium mixture) plus a paraffin moderator can also be used for slow neutron activation. Since these sources are currently used in commercial radioactive logging, it is possible to obtain an aluminum content log on the basis of slow neutron activation.

Research with gamma-ray sources. One part of Magnolia's nuclear physics research program has included a fundamental study of gamma-ray transmission and scattering in water, oil, and common earth materials. Theoretical and experimental investigations have been directed toward understanding the basic problems involved. One possible application of these studies, especially those with collimated gamma-rays, is the development of rapid and accurate means of measuring rock density. With collimation of the radioactive source and the gamma-ray detector it is possible to minimize the effects of borehole fluid on the response of a density logging tool. Since collimation greatly reduces the intensity of gamma-rays that reach the detector, it is desirable to use a scintillation crystal detector to maintain a high counting rate and hence have a reasonably fast logging speed.

ACKNOWLEDGEMENTS

The author wishes to express his appreciation to Drs. D. H. Clewell and C. I. Alexander for helpful discussions on the manuscript; to the staff of the nuclear physics research group for the data on which this report is based; and to the management of the Magnolia Petroleum Company for permission to submit this paper for publication.

FIG. 6. *Differential count of prompt gamma-rays from 14 Mev. neutron bombardment of calcium and silicon.*

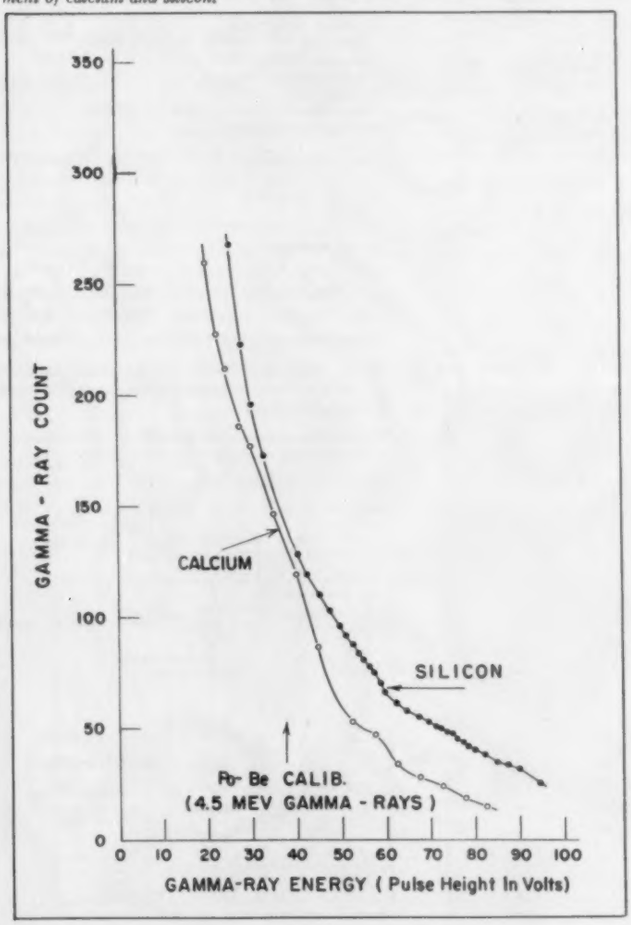


FIG. 7. *Relative activities induced per gram pure material 14 Mev. neutrons.*

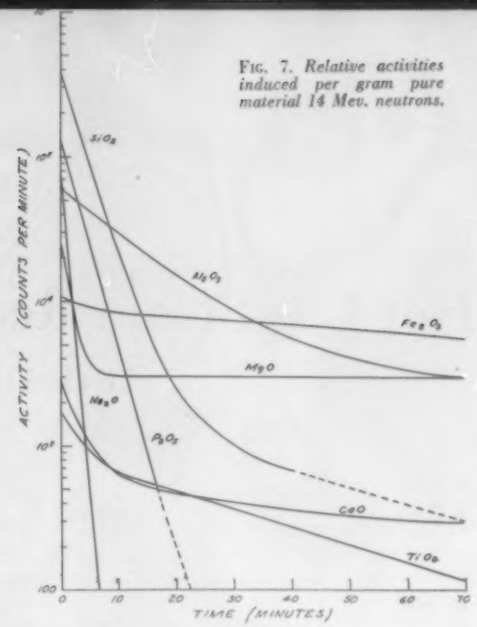


FIG. 8. *Decay curves, 14 Mev. neutron bombardment.*

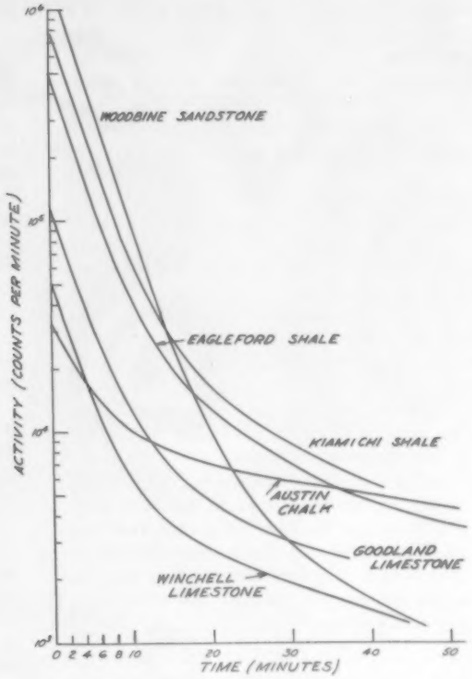
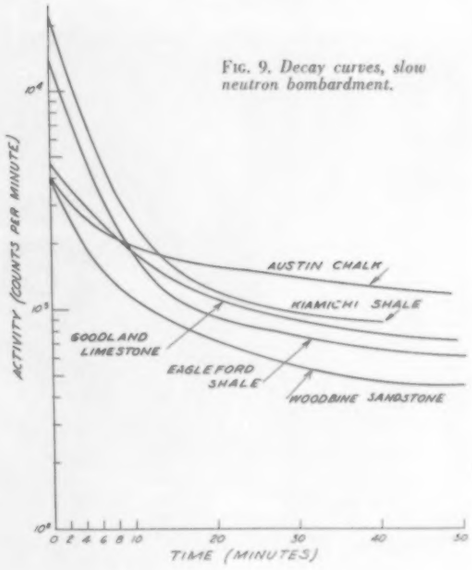


FIG. 9. *Decay curves, slow neutron bombardment.*



Hot Gas-Steam Recovery Method Tested in Illinois Field

Oxygen injected with hot gas-steam mixture induces spontaneous combustion in oil sand. Test in Illinois field recovers 80 percent of oil in place. Volume burned in-situ estimated at 10 percent.

By Richard Garbus[1]

A NEW thermal secondary recovery method has been tested in the Parker pool in Illinois by the Worthington Corp. in cooperation with the Forest Oil Corp. of Bradford, Pa.

In this new process the oil-carrying formation is heated through the injection of a hot-steam mixture. As the temperature of the sand increases, the oil viscosity decreases. Driving gases, introduced at injection wells, move the hot oil, now having a low viscosity, to the production wells where it is extracted to the surface.

Basically, all the heat required to raise the temperature of the formation could be developed by surface equipment. However, it is economically advantageous to burn a fraction of the crude directly in the formation to develop heat "in-situ." At temperatures considerably less than 400°F, it was found that if some free oxygen were present, combustion of the crude in the formation starts spontaneously. Therefore, all that is necessary to start the combustion "in-situ" is to add free oxygen to the injected steam-gas mixture.

As the process progresses, three basic zones appear around each injection well. The first zone has been completely depleted of its oil content. A gas mixture containing free oxygen is continuously driven through this zone, but no reaction can take place since no combustible matter is available.

[1]*Project engineer, Worthington Corp.*

The second zone is the combustion zone. The formation has been heated to or above the ignition temperature. Injected gas mixture containing free oxygen passes through this zone where some hydrocarbon matter burns. Generally, the temperature in this zone is about equal to the evaporation temperature of the heavy fractions of the crude.

In the third zone the formation temperature has not yet reached ignition temperature. Therefore, no reaction can take place here, although enough hydrocarbon matter is available. Even if the gases driven through this zone do contain some free oxygen, it will pass without reacting and act as a heat carrying medium only.

Purpose of the Worthington test was to find best conditions for economical oil recovery. The composition and temperature of the injected mixture had to be changed in a wide range and the power plant had to be designed to meet these changing operating conditions.

Fig. 1 shows the plant, while Fig. 2 shows the general arrangement of the components. Both equipment design and field tests were supervised by H. Walter, Worthington's director of research.

The plant consists of an air compressor, a gas compressor or fuel pump, and a water pump, all of which are driven by a 150 hp gas engine. Compressed air and fuel are injected into the combustion chamber (Fig. 3) where the fuel is burned at high temperature. Water first serves as a chamber coolant, and is then directly injected into the lower part of the chamber, producing a steam-combustion gas mixture. This mixture flows directly to the injection wells.

Here is the capacity of the plant and characteristics of the produced mixture:

Capacity: 400,000 scf per day of air; 55,000 lb. per day of gas-steam mixture.

Pressure: Up to 500 psig.

Temperature: 350°F to 900°F.

Composition: Can be varied from pure air to a mixture of combustion gas and steam. The amount of free oxygen can be varied from 23% to 0%, by weight.

Fuel for Combustion Chamber: Natural gas, propane or oil.

The Parker pool in Clark County, Ill. was selected as the test site. The thickness of the sand was 35 feet in a depth of approximately 275 to 310 feet. The characteristics of the sand and crude as found by laboratory analysis were as follows:

Average weighted porosity	—	20%
Average weighted permeability	—	400 to 700 Md
Average total water saturation	—	27%
Average oil saturation	—	45%
Total oil content	—	24,000 barrels per acre
Gravity of crude at 60° F.	—	26.3 API
Viscosity at 100° F.	—	178 S.U. seconds
Initial boiling point	—	335° F.

When the Parker pool was opened in the Twenties, the sandstone formation showed little natural production, but numerous

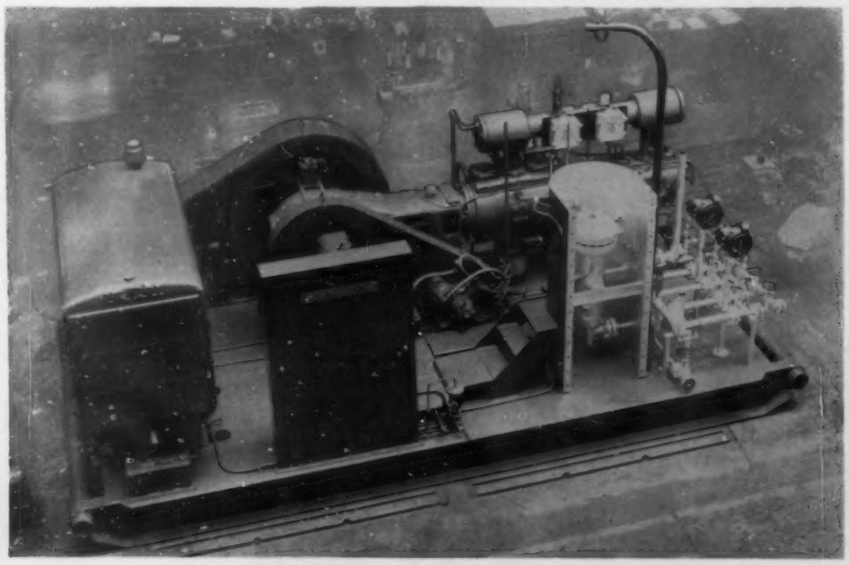


FIG. 1. *The plant for the hot gas-steam secondary recovery method tested in Parker pool, Illinois by Worthington Corp.*

FIG. 2. *The general arrangement of the components of the thermal secondary recovery plant.*

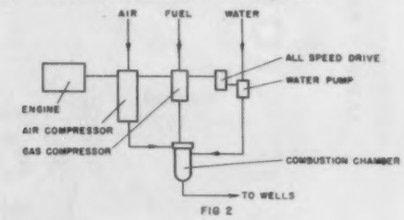


FIG 2

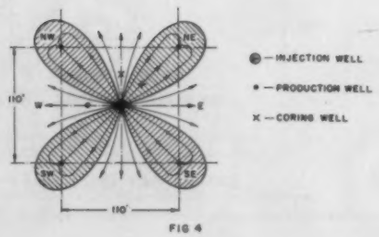


FIG 4

wells had been drilled through into the deeper limestone. Also, water drive tests had not been successful. Location of the test wells is shown in Fig. 4.

The two center wells (designated as the East well and the West well) were drilled first, while the four corner wells (NE, NW, SW and SE wells) were drilled after the tests were begun. After the tests were completed, wells No. 1 and No. 2 were drilled for coring only.

The piping to, and in, the injection wells was insulated with asbestos. Thermocouples were installed in the bottom of all production wells. No pumps were used to extract the produced liquids to the surface—the fluids were lifted by the produced gas which had been driven through the sand. The produced liquids were collected in a manifold and flowed to a gas separator, water separator and storage tanks. Provisions were made so that if desired, the production of each well could be measured separately.

Preliminary tests were begun in September 1953, with the two center wells placed 30 feet apart. A steam-gas mixture was injected into the East well. Approximately two weeks later the West well was beginning to produce steadily some gas, oil and water. The temperature in the West well slowly rose to 90°F in December, and rather suddenly in January, it rose to 220°F and higher. It remained at that level until the well was shut in.

The oil production of the well also increased rather suddenly, from less than one b/d in December to approximately 8 b/d in January 1954. It remained at that level until March, and then decreased until the well was shut in in April 1954.

All four corner wells reacted similarly. A rather sudden increase in the temperature of the well occurred simultaneously with an increase in oil production. From then on, the wells produced at high rates. The gas production kept on increasing, but the production of oil decreased after some time, and the wells were shut in.

The production history of the tests is shown in Fig. 5. The four corner wells were drilled and connected in December 1953 and January 1954. The wells heated up from October 1954 to April 1955. The tests was stopped before the SE well had heated to quite the same degree as the other wells. As soon as the tests were started, a non-uniformity in the permeability of the sand was observed. This is one reason why all the wells did not heat up simultaneously. Another reason was disturbance by an experimental water flooding operation to the south of this test, which hindered gas flow to the SE and SW wells.

An injection pressure of 350-400 psig was estimated as safe, and was maintained throughout the test. The mixture temperature was varied between 400°F and 900°F, with lower temperatures being applied during the latter part of the test.

The composition of the injected mixture was varied in a wide range. Almost no oxygen was injected in the beginning. Air was injected on only two occasions over periods exceeding one month. The average composition of the mixture over the duration of the test was:

Steam	—	40%
Nitrogen	—	47%
Carbon Dioxide	—	6%
Oxygen	—	7%

It should be noted that the production curves of Fig. 5 are influenced and distorted by the unsteady operation conditions and by several shutdown periods.

Approximately 50% of the injected dry gas was recovered from the production wells—the rest escaped into the field. Therefore, the area from which the oil was produced has a shape as indicated by cross-hatching in Fig. 4. It was calculated that this area is approximately equal to the area of the square between the four corner wells or 0.277 acre.

A total of 5,210 barrels of oil was produced by all wells and sold; another 90 barrels was on hand in tanks after the tests were completed. Oil losses due to evaporation, leaks and other reasons were estimated to be three percent of the total. This is equivalent to a production rate of 19,000 barrels per acre or to 80% of the original content—a very remarkable result especially considering that tests were discontinued while the wells were still producing, and that approximately 10% of the original oil content had been burned underground.

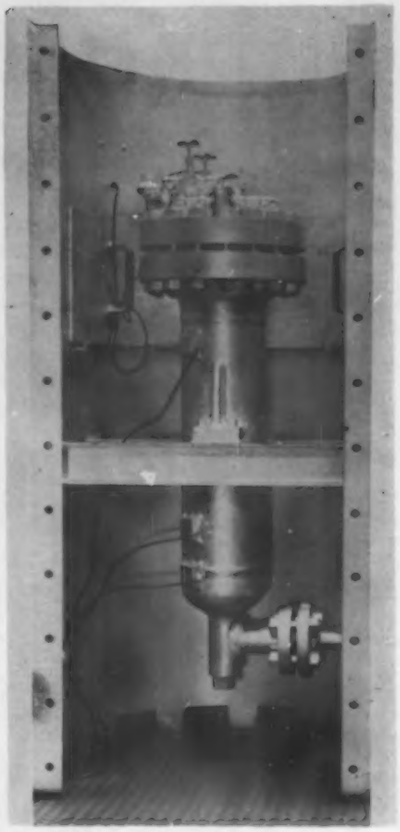
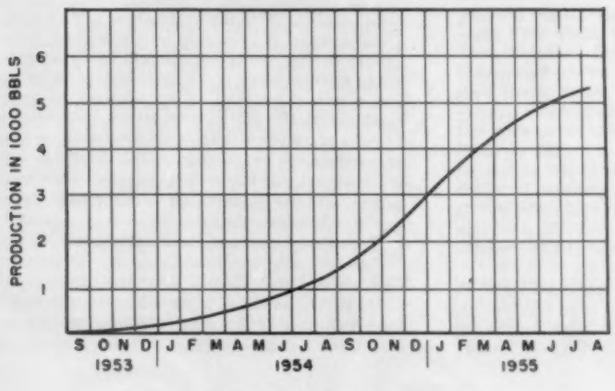


FIG. 3. *The combustion chamber where compressed air and fuel are injected into and the fuel burned at high temperature.*

The analysis of cores from wells No. 1 and No. 2 confirmed these figures.

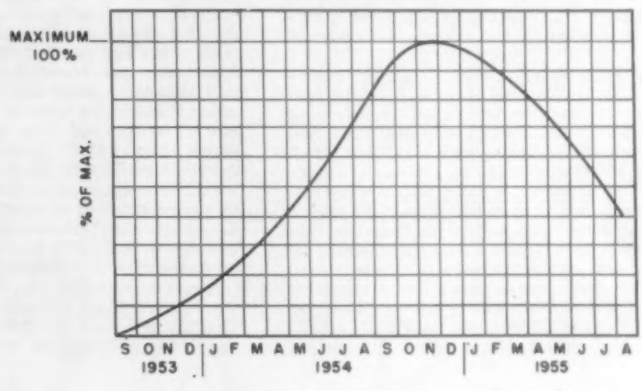
Besides the very high oil recovery rate that was achieved, enough information was obtained from the test to indicate that injection mixtures will produce the best results, and how the recovery process has to be conducted to be economical. All indications are that a project on a large scale (100 acres or more), with improved equipment, would be financially successful.

FIG. 4. *Location of the test wells in the Parker pool.*



CUMULATIVE OIL PRODUCTION

FIG. 5. *Production history of the tests.*



PRODUCTION RATE IN UNIT VOLUMES PER DAY

HYDROGENATIVE PROCESSING and DESULFURIZATION PATENTS

by Heinz Heinemann

This subject was last reviewed in the 1955 Annual Refinery Review issue of WORLD PETROLEUM. Its continued importance to the petroleum industry is evident from the predictions of expansion of reforming capacity and the constantly increasing use of relatively high sulfur content crudes. The flow of new patents in this field has been quite constant over the past two years, but the wide interest in the subject and the large volume of research and development work done on it are shown in the broadening of assignees of patents. Many companies are now obtaining patents in this field for the first time. The current digest covers the U.S. patent literature through January 1956.

Reforming Catalysts. The preparation of a stable noble metal catalyst is described in Esso Research & Engineering Co.'s 2,708,187 (K. K. Kearby). This catalyst is also resistant to platinum crystal growth during regeneration. The platinum is deposited in colloidal form on a carrier, together with a protective colloid such as colloidal alumina or silica hydrogel. About 0.05-2% platinum and 0.5-20% of the stabilizing oxide are used. After deposition of the two colloids, the catalyst can be impregnated with fluorine ion. In another Esso Research & Engineering Co. patent (2,728,713 K. K. Kearby, I. Kirshenbaum and G. R. Gilbert) a catalyst is claimed, which is supposed to be more selective for aromatics and high octane gasoline production than platinum-alumina or platinum-alumina-halide catalysts. This catalyst consists of 0.1-2% platinum on a zinc-alumina spinel base. The base contains 30-50% zinc oxide and 70-50% alumina and is prepared from the mixed hydrous oxides of zinc and aluminum.

A. G. Oblad and T. H. Milliken, Jr. (2,723,947 to Houdry Process Corp.) prepare a reforming and isomerization catalyst by leaching activated alumina particles with an aqueous acidic solution to modify the surface characteristics of the alumina while leaching less than 10% of alumina from the particle. The particles are then washed with water to remove the acidic anion and are impregnated with a noble metal compound of the platinum group.

A catalyst comprising 60-98% alumina, 1-20% chromia or molybdena and 1-20% of a phosphate of zinc, titanium, copper, iron or cobalt is used for reforming naphthas at 800-1200°F and 15-500 psig according to Union Oil Co. of California's 2,726,195 (R. N. Fleck and J. L. Bills). The catalyst is prepared by precipitation of the phosphate in a slurry of hydrous alumina. The calcined product is impregnated with chromia or molybdena.

A method for reactivating a platinum containing catalyst, which had become deactivated in the course of hydrocarbon conversion is described in Sun Oil Co.'s 2,724,703 (C. L. Thomas). Reactivation is carried out by contacting the catalyst with nitrosyl chloride.

Gasoline Reforming Processes. Feed stock preparation and particularly the removal from the feed of nitrogen compounds detrimental to reforming catalysts and to hydrocracking reactions is the subject of Universal Oil Products Co.'s 2,717,230 (M. J. Murray and V. Haensel). Gasoline is passed at 500-900°F, elevated pressure, a liquid hourly space rate of 4-20 and a hydrogen to oil ratio of 10 over a platinum-alumina-halogen catalyst. The resultant ammonia containing stream is then passed over solid phosphoric acid catalyst to separate ammonia from the gasoline. The latter is charged to a reforming unit. In another Universal Oil Products Co. patent, G. R. Donaldson (2,723,946) reforms a gasoline boiling range feed stock having a relatively high end point over a platinum containing catalyst, until the catalyst has lost activity. A feed stock with a lower end point is then substituted and reforming is continued until at least a portion of the lost activity has been recovered. The first feed can now be cut back in and reforming of the second feed stock is discontinued.

A group of Esso Research & Engineering Co. patents deals with various phases and modifications of fluid hydroforming. E. J. Gornowski in 2,710,827 discloses a method of operating a fluid hydroformer. J. Weikart in 2,710,826 describes a two-stage process for the reforming of a naphtha-kerosine fraction over a catalyst consisting of 10-12 wt. % molybdena on alumina or zinc aluminate spinel (see accompanying illustration). The first stage is operated at 200-1000 psig and 850-950°F, conditions at which continuous, non-regenerative operation is possible. In this stage naphthenes are converted to aromatics. Paraffin aromatization occurs in a second, regenerative stage. Only material boiling below 400°F is charged to the second stage, which operates at 925-1000°F and atmospheric to 60 psig pressure. Patent 2,717,860 (W. A. Rex) is concerned with a combination process, in which a straight run naphtha is hydroformed in a fluid zone, catalyst is withdrawn and regenerated and recycled. A portion of the recycled catalyst and of process gases are charged to a second fluidized zone (see accompanying illustration). In this zone a refinery stream is cleaned up by hydrogenation at a temperature and space rate which is lower than that prevailing in the first zone.

Two other Esso Research & Engineering Co. patents deal with methods of heat transfer in fluid hydroforming. In 2,721,167 E. W. S. Nicholson employs a mixture of finely divided catalyst and inert heat transfer solids in a fluidized bed. Solids are withdrawn from the unit, separated into inerts and catalyst and the inerts added to a stream of regenerating gas. The spent catalyst is discharged into this mixture. E. J. Gornowski and W. C. Rich (2,725,341) describe a method of better utilizing the heat of regeneration. Shot is mixed with catalysts in the regeneration zone and heated therein. Mixed regenerated catalyst and shot are then passed to a separate heating zone and mixed there with catalyst withdrawn from the reactor. After separation of catalyst and shot, the catalyst is returned to the reactor. G. E. Liedholm (2,730,556 to Shell Development Co.) discloses a method and apparatus for catalytic vapor phase dehydrogenation, in which all or substantially all of the heat of endothermic dehydrogenation reactions is supplied with a portion of recycled and highly heated product gas, consisting essentially of hydrogen.

A nickel reforming catalyst is employed by T. F. Doumani (2,732,329 to Union Oil Co. of California). Gasoline is passed at 850-1000°F over a catalyst comprising 0.4-20 wh. % nickel and 0.6-30% combined sulfate radicals on an alumina base carrier. A sufficiently long contact time is employed to effect a substantial improvement in the octane rating of the hydrocarbons.

C. E. Adams and C. N. Kimberlin (2,719,111 to Esso Research & Engineering Co.) reform virgin naphthas boiling in the range 100-275°F at pressures between atmospheric and 1000 psig and at 800-1100°F by contact for 0.01-2 seconds with an activated carbon catalyst. A fluidized bed is used. The reaction is carried out in the presence of a diluent, such as steam, process gas or hydrogen. Catalyst from the reaction zone is withdrawn and charged to a regeneration zone, where it is treated at 1200-2000°F with an oxidizing gas. Fresh carbonaceous material is constantly added and high ash content material is withdrawn.

Recovery of aromatics from "Dripolene" and other fractions containing aromatics together with large amounts of diolefins is described in American Oil Co.'s 2,717,231 (I. H. Lutz, O. W. Collier and D. J. Bellman). These fractions are charged to a hydroforming operation together with straight-run naphtha. The two streams are mixed in the top of the reactor to avoid excessive polymerization.

Reforming for Aromatics Production. The conversion of naphthenes to aromatics is the subject of Shell Development Co.'s 2,721,884 (W. M. J. Rvedisulj). Petroleum fractions are distilled into a C_6 fraction, containing C_6 cycloalkanes and a C_7 fraction, containing C_7 cycloalkanes. The latter fraction is contacted with a platinum containing reforming catalyst at 450-525°C in the presence of recycled hydrogen at 20-80 atm. pressure. Part of the hydrogen produced in this treatment is charged with the C_6 fraction to a platinum reforming catalyst at 450-525°C and 10-35 atm. pressure. Pure benzene is separated from condensed liquid product. N. Fragen and M. C. Hopkins in patent 2,727,077 (to The American Oil Co.) are concerned with the production of benzene from a naphtha containing both, cyclohexane and methylcyclopentane. The naphtha is fractionated to give a heart cut boiling between 150-185°F. This cut is subjected to catalytic reforming to convert most of its cyclohexane to benzene. The resultant product is fractionated to another heart cut of 150-185°F, from which benzene is removed and which is then isomerized over an aluminum halide catalyst. Components boiling below 157° are removed and the rest is recycled to reforming. A group VI metal oxide on alumina may be used as the reforming catalyst.

The reverse reaction, hydrogenation of an aromatic to an alkyl cycloparaffin is described by F. G. Ciapetta and J. B. Hunter in Atlantic Refining Co.'s 2,721,226. The reaction is carried out at 450-800°F in the presence of hydrogen and at 100-1000 psig pressure over a silica-alumina catalyst containing 0.2-

20% of nickel, cobalt, platinum vanadium, chromium, or tungsten. The base may contain between 98 and 40% silica and between 2 and 60% alumina.

J. D. Danforth (2,720,550 to the Trustees of Iowa College) converts naphthenes to aromatics by contact at 450-500°C and 0.25-500 atm. pressure with an activated carbon catalyst in the presence of sulfur dioxide. A sufficient molecular excess of hydrocarbons over sulfur dioxide is maintained to prevent the formation of free sulfur.

Catalytic Hydrogenation and Dehydrogenation. Esso Research & Engineering Co.'s 2,717,861 (P. K. Baumgarten, E. J. Hoffman and E. F. Wadley) discloses the selective hydrogenation of diolefins in a naphtha also containing monoolefins. The reaction is carried out at 350-650°F, 15-500 psig and a space rate of 1-20 V/V/hr over a molybdena or molybdenum sulfide catalyst. A hydrogen containing gas stream, containing at least 10 molar % hydrogen is used. A 1:1 mole ratio of gas to naphtha is essential for selective hydrogenation (see accompanying graph). According to another patent of the same company (2,728,712, I. Mayer) C_6 to C_8 alkanes in virgin naphtha are dehydrogenated along with naphthenes by contact at 800-950°F and 0-5 psig pressure with metallic lithium or lithium containing 10-20% calcium. Water must be completely excluded from the reaction. Lithium hydride is formed and part of the hydrided catalyst is withdrawn and regenerated in a separate zone by decomposing the lithium hydride at 1300-2000°F. Metallic lithium is recycled.

Production of cyclic olefins from naphthenes can be obtained according to G. R. L. Shepherd (2,721,225 to Esso Research & Engineering Co.). A C_5 ring naphthenic hydrocarbon boiling in the range 100-265°F is converted to a cyclic olefin over an activated carbon catalyst at 850-1150°F and at a pressure below 400 psig.

Hydrodesulfurization. The preparation of a cobalt-molybdena-alumina desulfurization catalyst is described in Union Oil Co. of California's 2,728,710 (G. W. Hendricks). An activated alumina, which may contain 3-8% silica is impregnated with an ammoniacal ammonium molybdate solution. The product is drained, dried and heated to 400°C. The resulting catalyst is impregnated with an aqueous solution of a cobalt compound and again drained, dried and heated to 400°C. The finished catalyst should contain 7-22% of the oxides of molybdenum and cobalt.

Autofining and desulfurization are treated in three British Petroleum Co. patents. According to P. Docksey, F. W. B. Porter and H. T. Porter (2,726,193) the product of an autofining process are partially condensed without reducing the pressure, to condense and remove undesirable higher boiling products. Gaseous products are further condensed at pressure in a second zone, to obtain liquid products containing dissolved hydrogen sulfide and hydrogen rich recycle gas at operating pressure. The liquid products are depressured to separate hydrogen sulfide. In 2,718,490 F. W. B. Porter describes the autofining of gas oils. The reaction is carried out at 750-800°F and a liquid hourly space rate not exceeding 0.5 V/V/hr. A cobalt-molybdena-alumina catalyst is used, which contains a minor amount of fluorine. F. W. B. Porter employs the same catalyst in 2,719,108 for desulfurizing a petroleum feed stock at 700-800°F and 500-1000 psig in liquid phase. The reaction products are contacted in a second zone with a sulfur resistant catalyst to effect dehydrogenation. Hydrogen produced in this zone is recycled to the first zone.

A combination desulfurization and reforming process is the subject of Socony-Mobil Oil Co.'s 2,724,683 (E. Nadro, Jr.). Catalyst flows downwards in a moving bed system, first through a reforming zone, then through a cooling zone and finally through a desulfurization zone. Desulfurization is carried out at lower temperature than reforming. The temperature of the catalyst and of the hydrocarbons is controlled by direct and indirect heat exchange.

E. S. Nicholson (2,717,855 to Esso Research & Engineering Co.) hydrodesulfurizes a heavy petroleum fraction boiling above 1050°F. The fraction is preheated to 700-900°F, passed to a soaking zone and kept there for 0.5-5 hours to coagulate and precipitate metallo-organic compounds and ash and thermally unstable high molecular weight compounds. The product is then hydrodesulfurized in liquid phase at 100-1000 psig and 600-1000°F with a slurried catalyst, such as bauxite, pyrites ash or cobalt-molybdena-alumina. Between 1 and 50 lbs. of catalyst are used per barrel of feed.

Two Gulf Research & Development Co. patents also deal with the desulfurization of heavy hydrocarbons. In 2,723,943 J. McAffee suspends in liquid hydrocarbons a finely particulate catalyst in an amount of at least 1.25 parts by weight per part of asphalt in the liquid body. The slurry is heated to 650-925°F at 250-2000 psig pressure, while hydrogen is passed through the suspension. Hydrogen and hydrocarbon vapors are removed overhead, until dry discrete catalyst particles are obtained, which are regenerated in a fluidized system. Vapor phase desulfurization of high boiling petroleum oils is practised in 2,733,189 (W. I. Gilbert, J. G. McNulty and C. W. Montgomery). Oil vapor and hydrogen are contacted over a hydrogenation catalyst at 750-900°F and 250-2000 psig until no more than 16 parts of oil have been contacted with 1 part of catalyst. Lower boiling components are removed from the product and the remainder of the desulfurized product is heated at 375-500°F for 15 minutes to 3 hours to convert residual sulfurous material to hydrogen sulfide. The catalyst is withdrawn and regenerated.

Catalysts consisting of titanium halide-phosphoric acid are used for the desulfurization of hydrocarbons according to Standard Oil Co. of Indiana's 2,726,991 (W. J. Zimmerschied and H. Shalit). These catalysts may also contain chromia or molybdena. The base is prepared by mixing ortho- or pyrophosphoric acid with a chloride or bromide of titanium. The ratio of halogen to active hydrogen in the acid should be between 0.4:1 and 1:1. The resulting mixture is heated to above 175°C until evolution of hydrogen halide ceases.

Sweetening. Processes for the sweetening of naphthas are claimed in a series of Standard Oil Co. of Indiana patents. M. D. Napper (2,727,849) sweetens catalytically cracked naphtha by contact in the presence of free oxygen with an aqueous solution of caustic and alkyl phenols, wherein the total caustic content is at least about 10 wt. % and the alky phe-

(Continued on page 83)

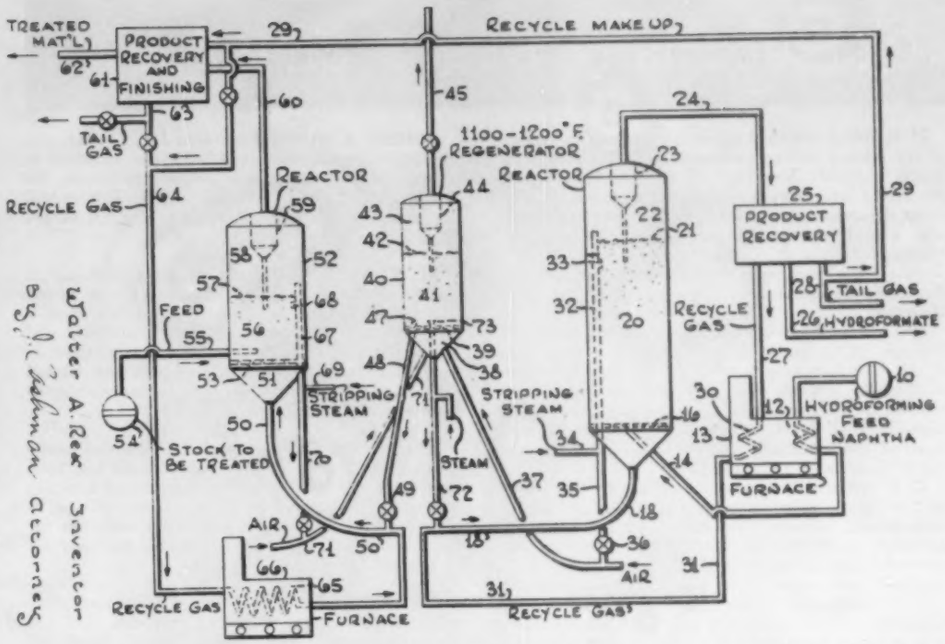
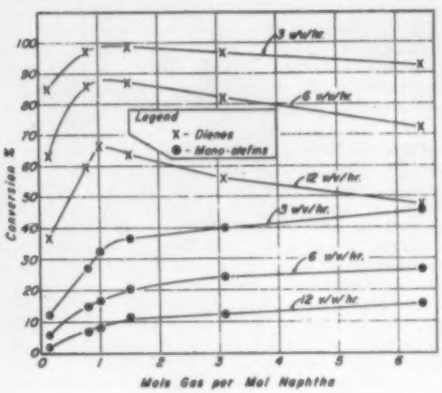


FIG. 1. *U.S. Patent 2,717,860. Flow diagram of fluid hydroformer modified to clean up a second refinery stream by hydrogenation and lower temperature and space rate.*

FIG. 2. *U.S. Patent 2,717,861. Effect of gas/naphtha ratio on the selective hydrogenation of diolefins.*



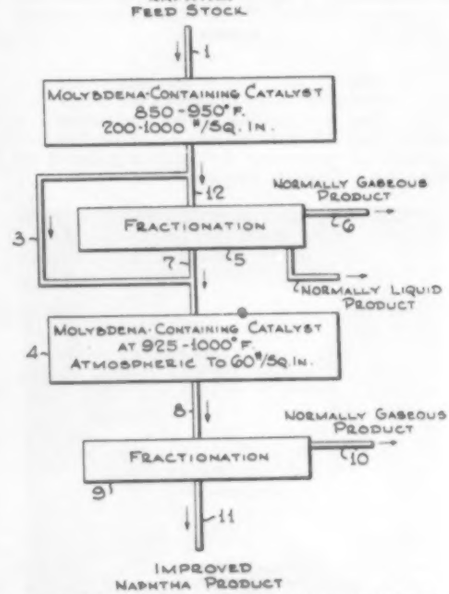


FIG. 3. *U.S. Patent 2,710,826. Method for hydroforming naphthas.*

Oil Company Staff Changes

M. G. BALL has been appointed assistant manager of the Amuay refinery, succeeding F. K. Davis. Mr. Davis succeeds Mr. Ball at Caripito. Lionel J. Bourgeois has been promoted to manager of the sales department, replacing W. B. Cleveland who was named manager of the Amuay refinery. He succeeds Calvin E. Cooper, who retired. C. H. Creamer has been appointed assistant manager of the sales department at Caracas, succeeding Mr. Bourgeois.

Dr. F. G. Baptista has been named assistant manager of the production department in Caracas; J. H. Creamer was named to succeed Lorenzo J. Mendive, retired, as head of the labor relations section of the industrial relations department in Caracas, and E. R. Adams has been appointed head of the insurance section, treasurer's department, Caracas.

W. J. Pfeffer will temporarily replace D. C. Meyer as head of the geophysical section of the geological department, Caracas. Mr. Meyer replaces G. C. Holcomb as assistant manager of the geological department. Mr. Holcomb replaces F. W. Johnson, on vacation, as manager of the geological department.

F. C. Hendryx was named assistant manager, law department; C. C. Irvine was appointed administrative assistant manager, industrial relations department of the corsortium companies in Iran; James S. McClendon was named head of the commercial affairs section in the law department; H. J. O'Malley becomes manager of the law department, replacing N. J. Campbell, who was elected vice-president, New York; and Ben Purdy was appointed supervisor of the training section at La Salina in western Venezuela.

FRED L. MACE, Alexandria, has been promoted to operations manager for Sahara Petroleum Co., a subsidiary of Continental Oil Co. operating in Egypt, it was announced by Millard K. Neptune, general manager. Formerly assistant to the general manager, he will continue to make his headquarters in Alexandria. Robert F. Fei, Alexandria, was appointed drilling superintendent for the company.

Mr. Mace joined Conoco in 1948 and became assistant in 1953 to the regional general manager in Denver. He joined Sahara Petroleum Co. in Egypt, as assistant to the general manager in 1955.

Mr. Fei was general superintendent of National Petroleum Co. in Egypt before joining Sahara this year. He is a native of Tucson, Ariz., and a graduate of the University of Arizona.

J. J. MIKITA has been named sales manager of the new additives sales group of Du Pont's Petroleum Chemicals Division with headquarters in Wilmington. His assistant will be W. W. Wingate, formerly in the product development group of the Petroleum Chemicals Division.

ROBERT A. HUNTER succeeds J. L. Lenker, who recently accepted the position of vice president in charge of marketing for British American Oil Company, Ltd. In his new position, Mr. Hunter will be responsible in a staff capacity for all of the company's domestic retail business.

A. W. BASS has been appointed manager of operations for The Atlantic Refining Co. of Brazil. He will be located at Rio de Janeiro. Mr. Bass is a graduate of Pennsylvania State University and joined Atlantic in 1937. Prior to this new appointment, he was operations manager of the foreign marketing department at the company's headquarters in Philadelphia.

JOHN G. McLEAN has been elected a vice president of Continental Oil Co. Mr. McLean has been associated with Continental as a part time consultant since 1948. In his new position, he will be in charge of coordinating and planning activities for Conoco and will continue to make his headquarters in Houston.

C. E. SKINNER has been named to the staff position of coordinator, marketing, for the Gulf Oil Corp. He succeeds R. A. Hunter, recently appointed general manger, retail and jobber sales of Gulf's domestic marketing department. In his new position, Mr. Skinner, a veteran of 23 years of service with the company, will share the responsibility for the formulation and coordination of policies, plans, and programs for Gulf's international marketing activities.

HOWARD F. THOMPSON has been promoted to the position of resident engineer of the Marcus Hook, Pa. refinery, Sinclair Refining Co. He succeeds John C. Weber, who is retiring after 32 years of service with the company.

DONALD J. WHETHAM has been transferred by International Petroleum Company, Ltd. from Lima, Peru to the company's administrative office in Coral Gables, Florida, as producing accounting advisor in the comptroller's department. A native of Calgary, Alberta, Canada, Mr. Whetham first joined the Company there in 1942.

CARL E. REISTLE, JR., vice president of Humble Oil Refining Co., Houston, has been installed as president of the American Institute of Mining and Metallurgical Engineers.

Mr. Reistle has been with Humble since 1936, serving first as engineer-in-charge of the petroleum engineering division. In 1940 he was advanced to head of the division, and in 1945 he was made general superintendent and became manager of production operations. He was elected a director of Humble in 1948 and made vice-president in 1955.

David A. Carnahan

DAVID A. CARNAHAN has been elected a vice-president of Drilling and Exploration Company, Inc., Los Angeles. He will be primarily concerned with foreign operations. Mr. Carnahan previously was chief engineer at Drilexco and has had a wide range of oil company and oil field equipment experience.

Drilexco, and its subsidiaries, are currently running 26 rigs in foreign areas which include Iran, Arabia, Brazil, Holland, France, Sicily and Nigeria.

GORDON W. REED, chairman of the board of Texas Gulf Producing Co., has been elected a director of Climax Molybdenum Co. Mr. Reed was elected president of Texas Gulf in 1941 and has served as chairman since 1945.

STUART E. BUCKLEY of Humble Oil & Refining Co., Houston, has been awarded the Anthony F. Lucas gold medal, the highest award offered by the American Institute of Mining and Metallurgical Engineers for outstanding service in the field of petroleum engineering. Mr. Buckley is the head of the production research division of Humble. At present, he is serving as acting assistant chief geologist of the exploration department. Presentation of the medal was made at the AIME annual meeting in New York.

OLIVER C. JOHNSON, manager of the Socony Mobil Oil Co., Inc., refinery at East St. Louis, Ill., has been appointed assistant general manager of the company's manufacturing department at New York. He joined Socony Mobil in 1934.

Harry A. Lutz succeeded Mr. Johnson as manager of the East St. Louis refinery. Mr. Lutz has been serving as assistant to the manager at the refinery and has been with Socony Mobil since 1939.

J. J. Mikita

Carl E. Reistle, Jr.

Oliver C. Johnson

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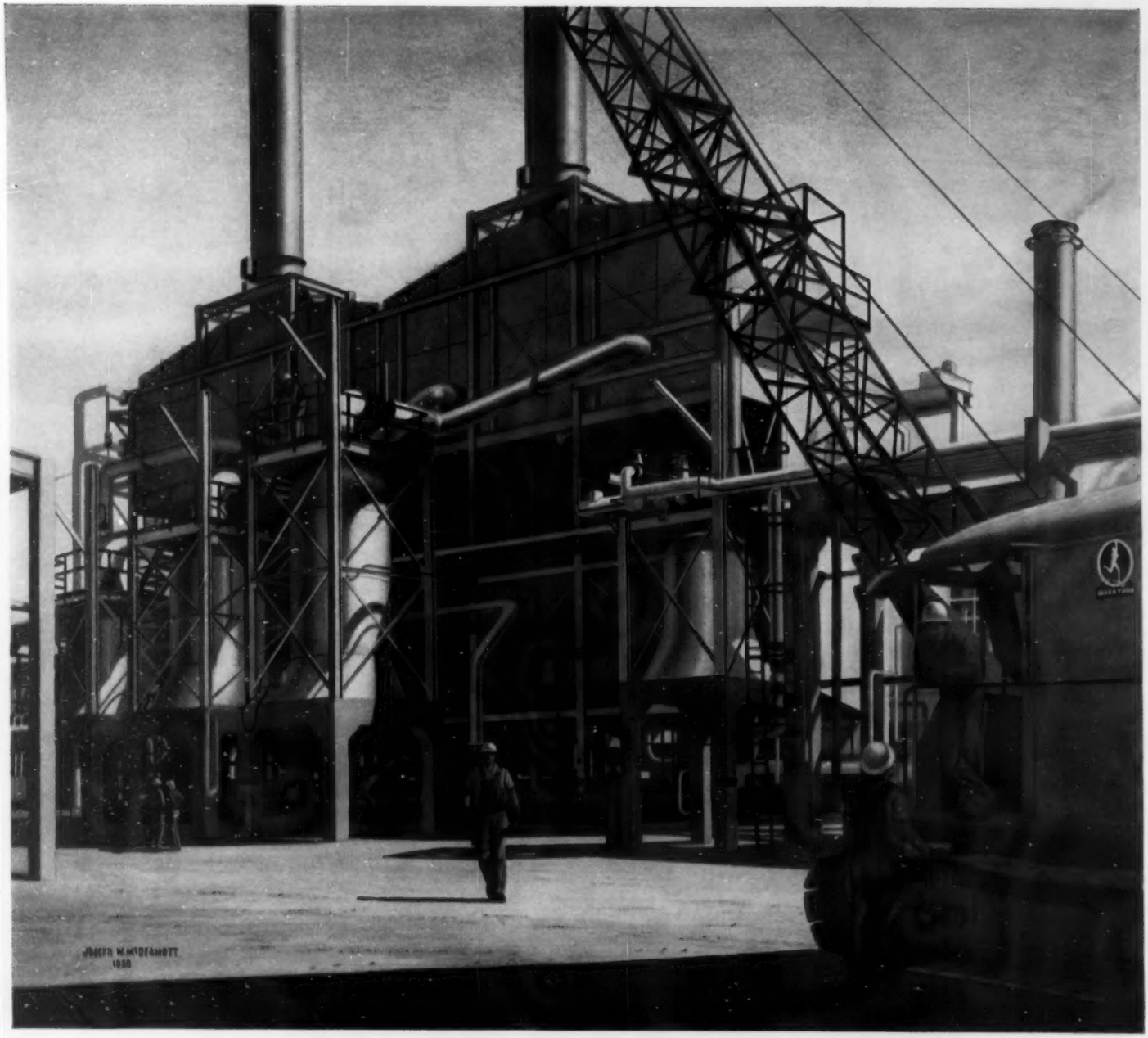
..... SCHLUMBERGER GOES !

Jo Spier



THE OHIO OIL COMPANY

The new Houdriformer of The Ohio Oil Company is the first catalytic reforming unit to incorporate regeneration facilities as an integral part of the basic design. Although the need for regeneration is infrequent, the catalyst in all three reactors can now be regenerated in-place.

This Houdriformer is also equipped with a "guard case" reactor as an integral part of the main unit. The "guard case" desulfurizes the charge stock as well as reducing other contaminants and eliminating pre-treating.

On stream at Robinson, Illinois, this Ohio Oil Company Houdriformer is an 8330 BPSD unit designed primarily for the production of high octane motor fuels. A new brochure describing the Houdriforming Process is available on request; for your copy, write to: Houdry Process Corporation, 1528 Walnut Street, Philadelphia 2, Pa.

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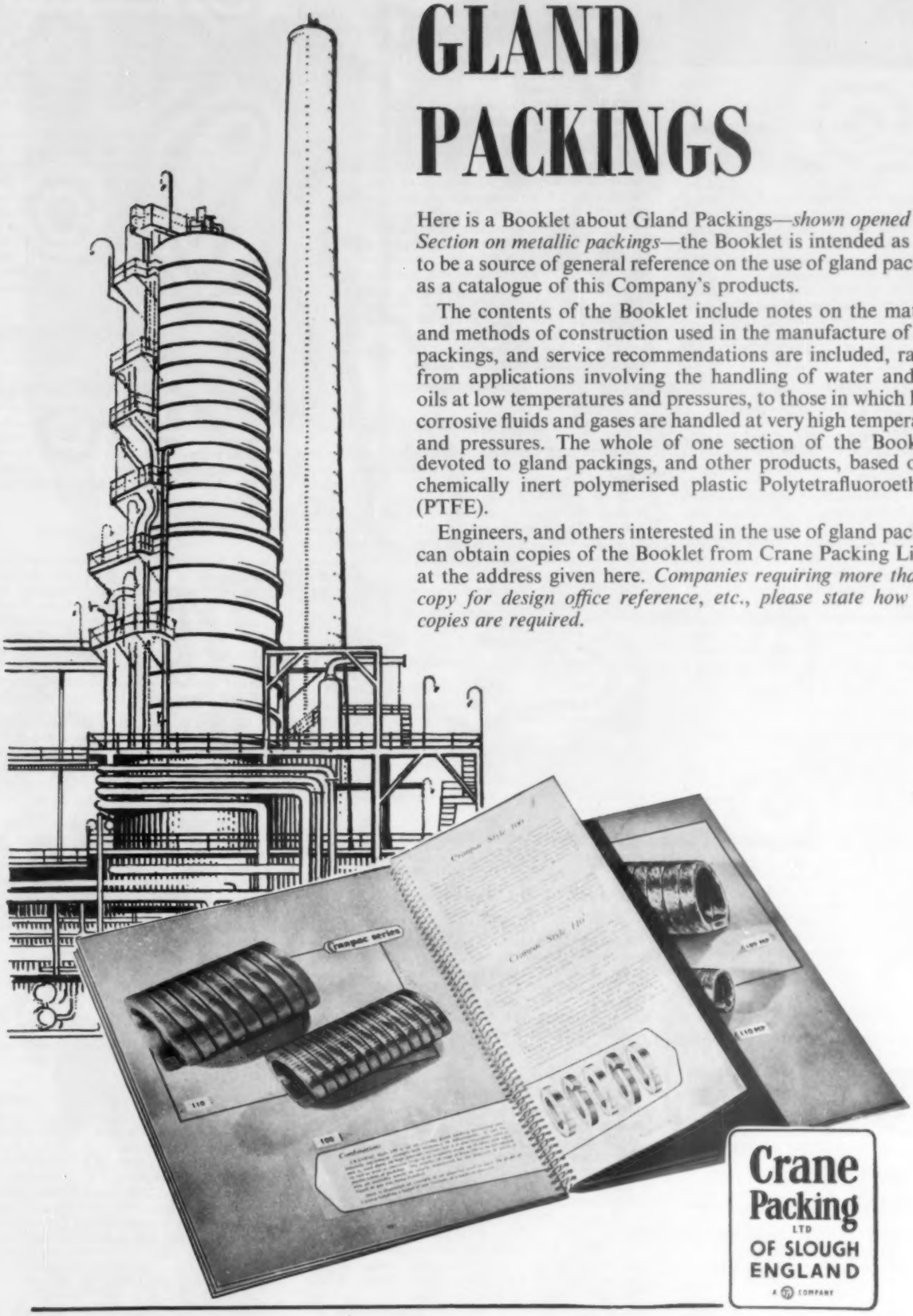
GLAND PACKINGS

Here is a Booklet about Gland Packings—*shown opened at the Section on metallic packings*—the Booklet is intended as much to be a source of general reference on the use of gland packings, as a catalogue of this Company's products.

The contents of the Booklet include notes on the materials and methods of construction used in the manufacture of gland packings, and service recommendations are included, ranging from applications involving the handling of water and light oils at low temperatures and pressures, to those in which highly corrosive fluids and gases are handled at very high temperatures and pressures. The whole of one section of the Booklet is devoted to gland packings, and other products, based on the chemically inert polymerised plastic Polytetrafluoroethylene (PTFE).

Engineers, and others interested in the use of gland packings, can obtain copies of the Booklet from Crane Packing Limited at the address given here. *Companies requiring more than one copy for design office reference, etc., please state how many copies are required.*



London Letter

Record Orders from Oil Companies

Orders worth £123.5 million for materials and equipment were placed in the U.K. last year by the oil companies, according to statistics collected by the Oil Companies Materials Secretariat and issued by the Council of British Manufacturers of Petroleum Equipment. This is 54% more than in 1954, when the total was £80.4 million, and over a third higher than the previous record figure of £91.4 million for 1952. The highest categories were: bulk chemicals, catalysts, barytes, etc., £23.5 million; tubulars, pipe fittings and valves (ferrous and non-ferrous), £18.1 million; specialised equipment for oil drilling and production (excluding pumps and valves), £12.4 million; and drums, drumsheets and tinplate £10.1 million.

Third Oil Dock for Manchester

Oil traffic on the Manchester Ship Canal has outgrown the facilities of the oil docks and canalside berths at Stanlow, and the Manchester Ship Canal Co. is engaged in examining a scheme for the provision of extensive new berths for this traffic so as to end the current delays through lack of cargo berths.

Speaking at the recent annual meeting in Manchester, the chairman—Sir Leslie Roberts, O.B.E.—said the company was promoting a bill in the present session of Parliament in which powers would be sought to acquire and reclaim land on which to construct Oil Dock No. 3. This is designed to form one of a group with the existing oil docks, Nos. 1 and 2, and it will be connected with the oil companies' installations on the south bank of the canal by pipeline through a new subway. The estimated cost of the proposed new oil facilities is £1¼ million.

Town Gas from Oil

Power-Gas Corp. Ltd., of Stockton-on-Tees, has received instructions from the South Eastern Gas Board to proceed with the construction of a Segas catalytic oil-gas plant at British Petroleum Co.'s Isle of Grain site in Kent. This will use refinery residual products and have a capacity of up to 20 million cubic feet a day of town gas, making it the largest cyclic gas making installation relying solely on oil as its raw material. The gas will supplement existing coal gas supplies through the Board's grid system. This type of plant has previously manufactured gas from oil in two large British centres and Segas plants are now being built in the U.K. and in Europe.

Further Kent Refinery Expansion

The Kent refinery of British Petroleum Co. on the Isle of Grain is to be further expanded at a cost of some £19½ million, raising crude oil throughput from 4½ to 7 million tons a year. Expansion will consist of a further distillation plant and ancilliary equipment scheduled for completion in 1957-58. This is in addition to the £6½ million project announced last November for a 130,000 ton/year aviation gasoline plant.

Reducing Diesel Engine Wear

M. J. van der Zijden of N. V. de Bataafsche Petroleum and A. A. Kelly of Shell Petroleum have given the Institute of Marine Engineers in London some facts on the development of a new emulsion-type lubricant for large low-speed marine diesels which proved so successful in laboratory trials that now over 275 ships are using it commercially and over a quarter-million hours have been run. Its use has resulted in considerable reduction in wear as compared with conventional lubricants, and marked improvements in piston, piston rod and cylinder cleanliness were also obtained.

£1,000m. Investment in Ten Years

The U.K. petroleum industry may need to invest £1,000 million. during the next 10 years to meet Britain's expected oil demands. This is the assessment of Esso Petroleum economists in the third of a series of articles in "Esso Magazine" reviewing the U.K. energy needs.

This assertion has aroused considerable interest among makers and suppliers of equipment and materials to the oil companies, especially as it is argued that recent Government statements on national fuel policy and the enlarged role petroleum is to play make it certain that assessments of U.K. oil needs made only a few months ago are now too conservative and it is suggested that oil demand will double over the next 10 years. On the basis that it costs up to £40 to increase capacity in all phases of operation by one ton a year "it still appears that a doubling of U.K. consumption over the next 10 years could entail a total expenditure on crude production, on new ships, and new plant and equipment of something in the region of £1,000 million." Production, it is estimated, could take up to £450 million of this, marine transportation £220 million, and refining and marketing £340 million.

U.K. Oil Needs in 1956

Government estimates of Britain's expanding use of fuel envisage the need for 300m. tons of coal equivalent by 1956, the House of Commons has been told by Aubrey Jones, new Minister of Fuel and Power. He hoped that at least 75 percent (225m. tons) of these requirements would come from home-produced coal and 3 percent (9m. tons)from nuclear power and hydro-electricity. In that case oil would have to be looked to for about 22 percent of 66m. tons. Last year the deficiency of 35m. tons of coal equivalent was met by oil.

New Grange Chemicals Plant

The new £1 million petrochemical plant of Grange Chemicals Ltd. at Grangemouth is reported to be now in full production at the rate of over 10,000 tons a year of very high quality detergent alkylate. This is based on raw material drawn from the nearby plant of British Hydrocarbon Chemicals Ltd., a company which is associated in Grange Chemicals with the Oronite Chemical Co. (San Francisco).

Company Finances

Lobitos Oilfields Ltd. maintains its interim dividend at 6%, less tax, in respect of the year 1955 despite increase in capital from £3 million to £3,-635,000. A similar interim on the smaller capital last year was followed by a final payment of 8%, together with a 2% distribution from capital profits. Preliminary results estimate group profits for 1955, before U.K. taxation, at £1.2 million, or about the same as for 1954. This figure is reached after charging development expenses in Peru of £600,000 (£341,591 in 1954).

Berry Wiggins & Co. Ltd., oil and bitumen refiners, maintains its total dividend payment for the year 1955 at 12½%, less tax.

Stevinson, Hardy & Co. Ltd., oil importers and distributors, declare an interim dividend of 5%, less tax, in respect of the year ending April 30th, 1956. This is the same as a year ago, the 1954-55 total being 15%.

Color Gas Holding Ltd. maintains its interim dividend payment for the year ending July 31st, 1956, at 12½%, less tax. For 1954-55 total payments were 37½%.

Cleveland Petroleum Co., motor fuel marketers and Esso Petroleum subsidiary, earned less in 1955. Earnings showed a fall from £301,725 to £252,889. The preliminary results show that, after crediting over-provisions in previous years of £25,682 and meeting tax charges of £168,500 (£253,750 in 1954), net profit is returned £36,414 higher at £84,389. Dividends are maintained at 15% on the ordinary shares and 27¼% on the deferred.

A very satisfactory year's trading, in which output and sales broke all previous records, was reported at the recent annual meeting by L. J. Dussek, chairman of Dussek Brother & Co. Ltd., bitumen product manufacturers. Raw materials had been more readily available and this had assisted in meeting the increased demand. He also reported that exports again showed a very useful increase and the company's products are being sold in many parts of the world. The outlook for their associated companies in Australia and Canada was also more promising.

Monsanto Chemicals Ltd., petrochemical manufacturers, reports record turnover for 1955 but slightly lower trading profits. Turnover was 7% up at £13½ m., a new record, but keen competition led to lower group trading profits of £2,818,568 against £2,940,407. A smaller tax charge of £791,-423, against £984,544, lessened the blow to net profits, which came out higher at £1,091,311 against £880,739. Ordinary dividends for the year were maintained at a total of 22½%, less tax. Export volume of products was again increased.

Bunker Oil Price Rise

Shell Petroleum Co. raised its bunker oil fuel prices at sterling-priced ports by 2s. to 9s. 6d. per long ton on February 8th. Rises are stated to reflect higher tanker freight costs, particularly from the Persian Gulf, in recent months, but not all the higher costs, it is understood, have been added. Prices at U.K. main installations went up 5s., current prices ranging from 160s. per ton for marine fuel oil to 240s. for marine diesel oil and 268s. for gas oil.

Personnel

E. P. Barribal, M.B.E., general sales manager (automotive) of Mobil Oil Co. Ltd., recently celebrated 30 years' service with the company. At a luncheon given in his honour at the Savoy Hotel, London, to mark the occasion, he was presented by the directors with a pair of inscribed cufflinks. Mr. Barribal has held his present position since 1952 and previously, as manager of the automotive fuels department, was responsible for introducing Mobilgas and Mobil Diesel to the U.K. retailer market.

Richard N. Augustson, of Monsanto Chemical Co.'s inorganic chemical division's development department, St. Louis, has joined Monsanto Chemicals Ltd. in England on a two years' assignment. He will be concerned primarily with economic evaluation studies and the progressing of British projects.

H. R. Walton, B.Sc., sales manager of Fisher-Governor Co. Ltd. has been appointed a director.

Sir Walter Drummond, who resigned recently as deputy chairman of the National Coal Board, has joined the board of Sigmund Pumps Ltd. Sir Walter has served on the Advisory Council of the Department of Scientific and Industrial Research and on numerous other bodies connected with industry and research.

John E. Harvey has been appointed a director of Manchester Oil Refinery (Sales), Ltd. The boards of the latter company and of Lambert Brothers Ltd. have agreed that Manchester Oil Refinery (Holdings) Ltd. will acquire the complete control of Marine and Industrial Lubricants, Ltd. as from February 1st.

Lord Geddes has been appointed tanker adviser to the Peninsular and Oriental Steam Navigation group of companies, a new post following the group's decision last September to enter the tanker field for the first time and to build a fleet of 25 vessels. About 500,000 d.w. tons are being ordered for delivery between 1958 and 1960. Lord Geddes served with the Shell group from 1931 to 1946 and later became a partner in Chr. Salvesen and Co., whaler and tanker owners. He left this position in 1950 to form his own tanker business.

Miles B. Reid, Sales Director of Mobil Oil Co., left for the U.S.A. in the "Queen Elizabeth" on February 25 for a month's visit to study Socony Mobil's fuel oil marketing. With him were H. D. B. Lorraine, director of Charrington, Gardner, Locket & Co. Ltd., and H. W. Sharland, managing director of Associated Coal & Wharf Co. Ltd., these two companies being United Kingdom sole distributors of Mobil fuel oils in their respective areas.

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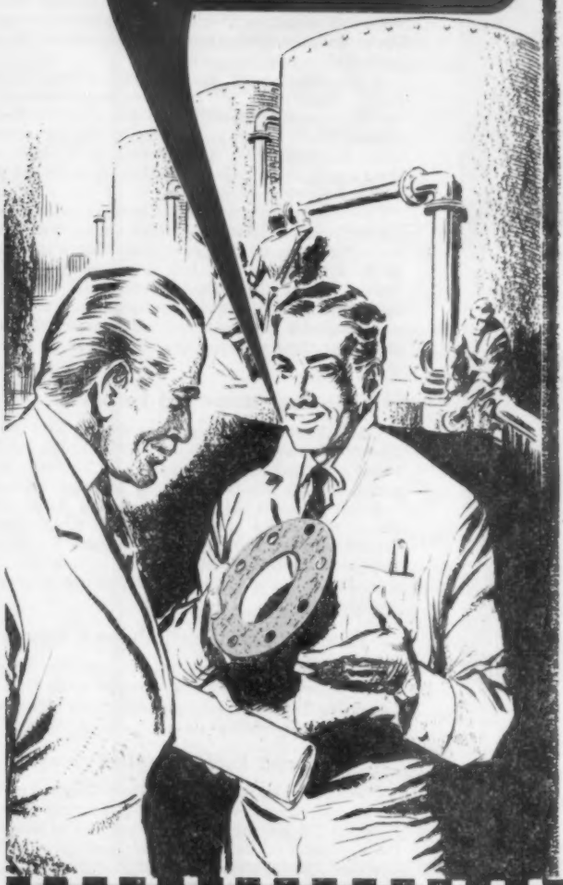

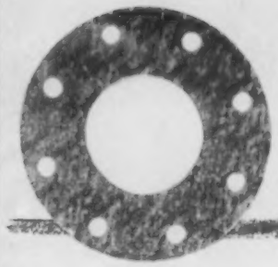

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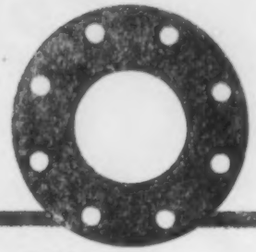

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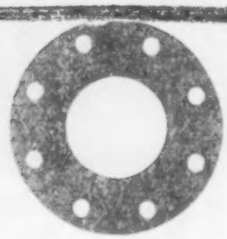

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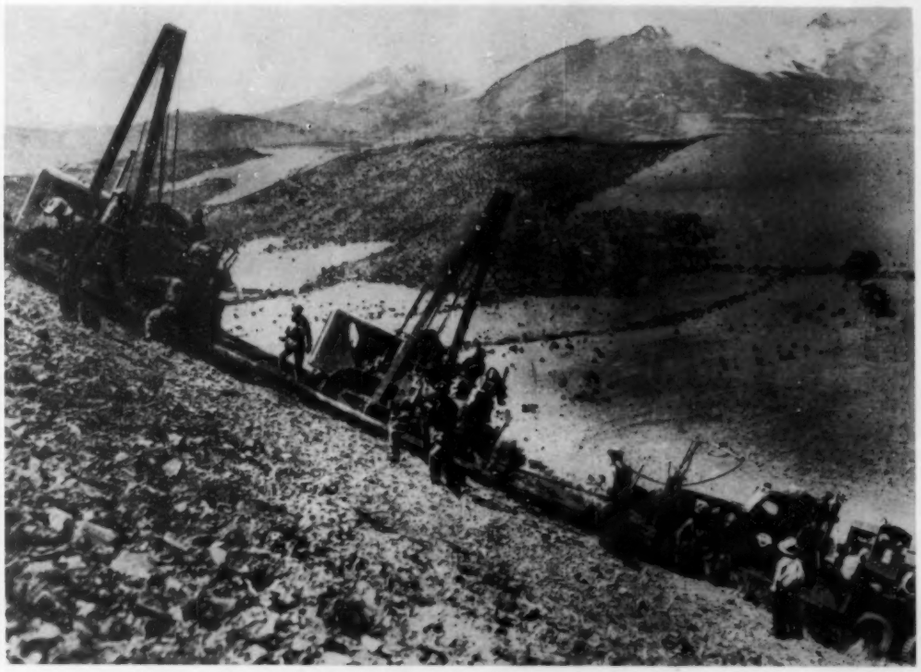
Latin American Oil News



Supercharged equipment and hand-picked crews on the Williams Brothers Bolivian pipe line project took 45% grades in stride as the 6-inch line moved north from Cochabamba to La Paz to become the first phase of the highest pipe line in the world.

World's Highest Pipe Line Crosses Bolivian Andes

The first phase of the world's highest pipe line is finished. Built by Williams Brothers, the line twists its way through passes in the forbidding Bolivian Andes for 220 miles at heights up to 14,835 feet above sea level.

The first phase, a 6-inch products line, joins the refinery at Cochabamba with La Paz, the capital of Bolivia.

When the second phase is built, it will join the line network at Sicasica, in the mountains of western Bolivia, to deliver crude to Arica, on the coast of Chile. Dropping 15,000 feet in only 48 miles, the swiftly-flowing crude will generate a vast amount of energy. It is planned to employ this energy to power a petroelectric plant.

This is the fourth project that Williams Brothers has completed for the Bolivian government. Williams Brothers handled the whole project, from logistics to physical examinations for its employees. Material and equipment was sent from factories and field points all over the United States and Europe to seaboard shipping for delivery to the seaports of Antofagasta and Arica, Chile.

At these shallow harbors, far down the coast from the construction site, it was unloaded by barge and put on trains which carried the equipment up steep mountain slopes to a central construction site where it was loaded on trucks for the last lap. The whole project was constantly threatened by landslides because of the loose character of the terrain.

Construction crews were hand-picked by rigorous physical examinations to be sure they could stand the strain on heart and lungs of working in the thin air 14,000 feet above sea level. Whenever possible, the firm hired national labor more accustomed to the altitude, for the actual construction. All tractors and equipment had to be supercharged.

Though the construction was carried on within 16° south of the equator, the cold was piercing. Eighteen inches of snow fell during July.

Despite all difficulties, equipment was delivered on time and the line, which was begun last spring, has now been completed, tested, and is in use.

The president of Bolivia, Dr. Victor Paz Estenssoro, Edwin M. Hubach, Williams Brothers general superintendent, and Garland Evens, welder, celebrate the final weld at La Paz.

British American In Nicaragua

British American Oil Producing Co. is reported negotiating with the Nicaraguan government currently for exclusive petroleum exploration and exploitation rights in an area on Nicaragua's Caribbean coastal section.

The only other concession is the Miguel d'Escoto concession, which covers the east and west sides of the country. (Concession maps are available through WORLD PETROLEUM). It was taken out before World War II. It was suspended for the duration thereof, and recently re-installed until Dec. 31, 1958.

Brazilian Production

Petrobras announces that local production of gasoline supplies 76% of national needs; kerosine, 89%; diesel oil, 33%; fuel oil, 45%; liquefied gas, 80%; solvents, 90%. Imports of crude increased by 2,165,004 tons during the first 8 months of 1955, to 2,177,934, while imports of gasoline, diesel and fuel oils dropped by 750,427, 61,523 and 335,982 tons, to 754,568, 715,251 and 1,526,735, respectively.

Oil Find In Costa Rica

Union Oil Company of California reports that their Cocolas #1 well in southern Costa Rica has encountered a good flow of high quality oil at 5,450 feet. The pay thickness was given at 114 feet.

The formation has been sealed off and drilling resumed. Considerable salt water has been encountered, Joel Lloyd, general manager of Union's local subsidiary, Compania Petrolera de Costa Rica, S. A., stated and it is probable that drilling will be halted and production will start from the area already located in the well.

The official stated that it is "practically certain" that the company will drill at least one additional well in the area. Cocolas #1 is located in a dense jungle area, 1 mile from the border of Panama and 21 miles from Costa Rica's Caribbean coast.

Mr. Lloyd stated that to date the company has expended some $5 million in Costa Rica on oil exploration and test drilling. Four previous wells drilled in the border area by Union were abandoned.

Sinclair Oil Co. did considerable test drilling along the Panama-Costa Rican border area in 1919 and later in 1940, but without success.

Majors Interested In Bolivia

Visits by J. Loofbourow and S. Chillingworth of Richfield Oil Co., Myron Gretler of Socony Mobil's Peruvian subsidiary, and Dr. Voorwijk of Shell's Peruvian subsidiary, indicated heightened interest in Bolivia's possibilities.

A petroleum law passed in 1955 (WORLD PETROLEUM, January pg. 68) has been supplemented by the Regulations, passed within the specified 90-day period. They permit companies to file for concessions following 9:00 A.M., February 25, 1956, and their applications will be decided upon by the 26th of the following month.

The law is not yet final. It has yet to be passed by the Bolivian Congress, which comes into session during August of this year, following elections to be held this May. The bill, if passed, will be approved about September. Meanwhile, concession applications may be made, however, and the guaranty deposits required will be considered provisional for their return if the bill is held up in Congress.

Argentine Oil Imports

Crude imports into Argentina during 1955 totaled 3,841,801 metric tons (about 76,836 b/d). Product imports totaled 7,230,628 tons (about 144,612 b/d) of which fuel oil was 2,600,263 tons (about 52,005 b/d), aviation gasoline 54,111 tons (about 1,082 b/d); Diesel oil 132,314 tons (about 2,646 b/d), gas oil 401,022 tons (about 8,020 b/d); kerosine 201,115 tons (about 4,023 b/d). Comparative figures for 1954 were 73,569 b/d of crude and 125,530 b/d of product imports.

Jusepin Crude Oil Price Change

Creole Petroleum Corp. has announced a revision to the posted price of Jusepin crude oil to $2.74 per barrel for 32.0/32.9° API gravity, down eight cents from previous posting.

Boscan Field Crude Prices

Prices for crude oil from the Boscan Field in Venezuela have been posted for the first time by Richmond Exploration Co., a subsidiary of Standard Oil Company of California. The new price is $1.55 per barrel, f.o.b. Richmond's station tanker at Punto Fijo, Venezuela, and $1.52 per barrel, f.o.b. for full cargoes at its Bajo Grande deep water loading terminal in Lake Maracaibo.

Prices which are subject to change without notice are flat prices with no fluctuation for gravity.

Brazilian Drilling & Exploration

During 1955, 446 wells were completed. 268 were oil producers and 34 gas producers.

In January drilling started on pioneer well G-IRN at Grossos, Rio Grande do Norte, a new exploration area, reached 2,600 feet at NO2-AZ, 0.6 miles from NO1-AZ (Nova Olinda), and 2,275 ft. at RK1-AZ, on the Abacaxis River, 60 miles south of NO1-AZ. The level of oil in NO1-AZ rose to 300 meters in January, a pump is due to arrive and the rig is being moved to another position. Drilling is about to start at NO3-AZ, 2.4 miles from NO1-AZ.

WHY IS PETRECO-DESALTED CRUDE A SAFER REFINERY CHARGE THAN A NON-DESALTED "LOW-SALT" CRUDE?

Even "low-salt" crude causes trouble. The trend in desalting performance is increasingly toward maximum removal, minimum residual salt.
Petreco desalting provides removal percentages in the 98 to 100% range, with residual salt averaging 1.5 ptb, and less.

A "low-salt" crude often contains solids such as sand, silt, rust and other plugging or abrasive materials to such a degree that they are more troublesome than salt.*
Petreco desalting effectively removes such solids and fines.

A refinery operation planned on a "low-salt" charge is greatly upset if it becomes necessary to charge a salty crude.
Petreco desalting insures smooth operations regardless of the salt and solids content of the crude charge. Petreco desalting has effectively desalted every crude charged to it.

Minute quantities of arsenic can be present in any crude, "low-salt" or otherwise, and severely impair catalysts.
Petreco desalting reduces arsenic, stops catalyst poisoning.

Regardless of salt content, "slugs" of water are sometimes picked up in the crude charge when tanks are switched. Such water-slugs play havoc with distillation equipment.
Petreco desalting eliminates the hazard of water "slugs."

The storage of crude oils in the refinery often results in the deposition of "tank bottoms." These bottoms displace storage capacity, and cause an expensive disposal problem.
With Petreco desalting in the refinery, tank bottoms can be metered into the crude charge and easily disposed of.

*In one refinery, usually charging crude containing only 5 ptb, Petreco desalting showed a rapid pay out solely on the basis of solids removed.

6 REASONS WHY PETRECO DESALTING IS PREFERRED BY SO MANY LEADING REFINERS

1
2
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International News and Notes

First Quarter World Crude Production Exceeds 16 Million B/D

World crude production increased by about 2.5% to 16,124,000 b/d in the first quarter of 1956, according to estimates by WORLD PETROLEUM. The increase occurred mostly in North America, but Latin America and Europe also raised production.

WORLD CRUDE OIL PRODUCTION
(Thousands of Barrels Daily)

	1955 Fourth Quarter	1956 First Quarter
United States	6,932.6	7,106.1
Canada	405.1	438.2
Mexico	229.8	251.0
TOTAL N. AMERICA	7,567.5	7,795.3
Venezuela	2,255.6	2,324.5
Colombia	113.2	115.6
Argentina	85.1	85.9
Trinidad	72.3	71.0
Peru	47.3	47.5
Ecuador	9.7	9.6
Chile	8.6	8.1
Brazil	6.4	6.3
Bolivia	8.5	8.5
Cuba	1.4	1.5
TOTAL S. AMERICA & CARIB.	2,608.1	2,678.5
WESTERN HEMISPHERE	10,175.6	10,473.8
Austria	66.4	68.7
Germany (West)	64.1	64.4
France	21.3	20.7
Netherlands	19.4	19.3
Italy	6.5	7.0
Yugoslavia	3.0	3.0
French Morocco	2.0	2.0
United Kingdom	1.3	1.2
Algeria	1.1	1.0
TOTAL EUROPE & AFRICA (EXCLUDING USSR & SAT.)	185.1	187.3
USSR	1,375.0	1,400.0
Romania	200.0	222.0
Hungary	24.0	28.0
Poland	4.0	7.8
Albania	6.0	6.0
Czechoslovakia	2.5	2.5
TOTAL USSR & SAT.	1,611.5	1,666.3
TOTAL EUROPE	1,796.6	1,853.6
Kuwait	1,030.0	1,125.0
Saudi Arabia	1,025.9	1,000.0
Iraq	713.2	714.3
Iran	359.9	360.0
Qatar	111.8	120.0
Egypt	28.2	25.7
Bahrain	30.1	30.0
Neutral Zone	26.7	30.0
Turkey	6.0	6.4
TOTAL MIDDLE EAST	3,331.8	3,411.4
Indonesia	245.9	247.0
British Borneo	112.0	112.0
New Guinea	7.2	8.0
India	7.5	7.5
Japan	6.2	6.2
Pakistan	5.1	5.1
Burma	3.7	3.7
China	2.0	2.0
TOTAL FAR EAST & OCEANIA	389.6	391.5
TOTAL EASTERN HEMISPHERE	5,518.0	5,656.0
WORLD TOTAL	15,693.6	16,124.0

The increases in North America were partly due to rising production in the United States, which rose by about 173,500 b/d, but Mexico and Canada showed increases as well. In the case of Canada the increase was due to the larger quantities of crude which are going to the United States, dramatically illustrated by the first offshore shipment of Canadian crude to California which left about the first of the year in a tanker belonging to Tidewater Associated Oil Co. It illustrates the increasing quantities of Canadian crude which U. S. refiners are taking, both on the West Coast where Shell's Anacortes refinery went into operation recently along with others in the area, and in the Twin Cities area which took deliveries during the first quarter. In Mexico the hurricane damage artificially depressed production levels during the last months of 1955 so the increase is due to restoration of normal production levels and is not significant.

South American output averaged about 2,678,500 b/d during the first quarter, up by about 70,400 b/d. This increase was mostly due to seasonal increase in demand in Venezuela, where increasing use of residual during the winter months brings up production levels. The increase was easily absorbed in the U. S., however, and eased the import controversy for the time being. Another country showing some increases during the last few months is Colombia. There The Texas Company's new 20,000 b/d pipe line from the Velazquez field went into service permitting an increase in Colombian exports.

In Europe the Parentis and Mothes discoveries in France continued to have their effects. Pending construction of a pipe line for these fields, however, production is restricted. The European rise of around 1,800 b/d was attributable mostly to the increase in Gulf's Sicilian property. Sicily also must await the construction of a pipe line to realize its potential. Austrian production made the largest single contribution, up by about 2,300 b/d over the previous quarter. Reliable figures have only been available since the Russians left in the fall of 1955.

The Soviet orbit in Europe contributed little in the way of increase; however, reliable figures on this area are not available. Most estimates agree, however, the increases were registered in many of the Iron Curtain countries during 1955, particularly in Romania. The new series of Five Year Plans envisages an almost 100% increase in the over-all Iron Curtain production over the next five years.

In the Middle East production was up very slightly by 79,600 b/d. Part of this increase was in Iran, where the government is urging increases to help balance the budget. Production in the Neutral Zone was down in the last months of 1955, but recovered in early 1956. Kuwait increased slightly, but this was compensated for by Saudi Arabia, which decreased 25,900 b/d.

Yugoslavia Crude Production

Crude oil production in Yugoslavia is near record levels, and the long run outlook is for output "to continue to increase," according to U. S. officials in Yugoslavia.

During 1955, crude output was over 250,000 tons, about 5,000 b/d compared with 216,299 (about 4,326 b/d) during 1954.

Crude production is well below the demands of Yugoslav refineries, however, which had a total output of about 735,000 tons during 1955.

Neutral Zone Exports

The Kuwait-Saudi Arabia neutral zone sent forth exports of nearly 4,500,000 barrels of crude oil during 1955, according to reports reaching official American channels.

The November exports came to 349,583 barrels, and the first 11 month figures came to 4,143,588 barrels.

The area is under operation by the American Independent Oil Co. and Pacific Western.

The signing of the concessions agreement between representatives of The British Petroleum Co. and the Libyan Government. Left to right: Mr. D. R. Macpherson (representative of D'Arcy Exploration Co. (Africa) Ltd.), Salam al Qadi (Minister of National Economics, Libyan Government), Anis al Qassin (Chairman of Petroleum Commission, Libyan Government) and Mr. K. R. Henshaw (D'Arcy Exploration Co.). The British Petroleum Co. has received four concessions totaling 6,400 square miles, mostly along the coastal belt.

Exploration In Switzerland

A Swiss oil prospecting and exploration group has been organized, headed by Schmidheiny of Heerbrugg. The group includes Sulzer Brothers Ltd. of Winterthur; George Fischer, Ltd., of Schaffhausen; and NOK, Nordostschweizerische Kraftwerke, electric power and gas works. An experienced German drilling company is prepared to contribute three million francs of the estimated 12 million needed (about U.S. $13 million).

Another exploratory development occurred when the legislative council of Zurich Canton on Jan. 30 approved a petroleum prospecting and exploration agreement between the cantons of Zurich, Bern, Solothurn, St. Gallen, Aargau and Thurgau. A referendum is to be held in April in Canton St. Gallen, the first canton to seek final approval.

D'Arcy Exploration Co. has carried out geophysical surveys over both Malta and the even smaller neighboring island of Gozo.

Drilling has begun at site No. 1 near Zabbar (shown above), situated about three miles inland from the capital city of Valetta. A truck-mounted portable drilling rig is being used.

Stirling Moss takes first place, in the fastest R.A.C. T.T. of all time. Fangio and von Tripps took second and third. Each drove a Mercedes 300SLR—using BP Super.

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Canadian Notes

To Enlarge Products Line

Imperial Oil Ltd. will increase by one-third the capacity of its Sarnia-Toronto oil products pipe line. The line carries products 195 miles from the company's Sarnia refinery to Toronto with a take-off point at London and a spur line into Hamilton.

New construction will be a 12-inch loop from Waterdown to the company's new North Toronto terminal. The 38-mile loop will add 12,600 barrels capacity a day to Toronto. Additional pumping equipment will be installed at Sarnia, London and Waterdown which will increase the capacity of the whole line by 21,000 barrels a day. This will bring the total daily capacity to over 76,000 barrels a day

F. C. Lantz, manager of the pipe line division of Imperial's transportation and supply department, said the expansion program is expected to cost approximately $1,750,000. The new line is to be completed by next September.

Triad Oil Report

The fourth annual report of Triad Oil Co., Ltd. covering the year ending Nov. 30, 1955, reports Triad's petroleum and natural gas reservations and leases in Western Canada are 3,191,821 acres. Income from production for the year, after providing for royalties and well operating costs, amounted to $1,191,962. Net income was $624,764. Under terms of agreement with D'Arcy Exploration Company Ltd., owned by British Petroleum Company, Ltd., London, England, that company is committed to purchase an additional 3,800,000 shares of Triad stock before Dec. 31, 1958, bringing D'Arcy's interest in Triad up to approximately 50%.

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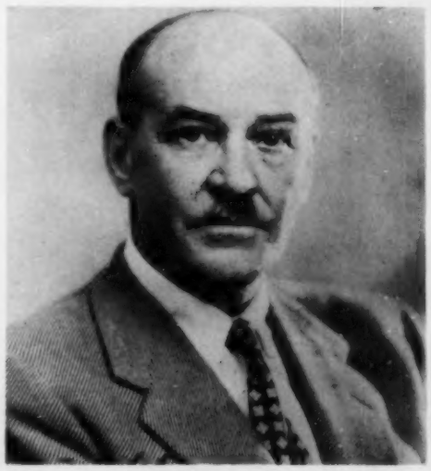
Saskatchewan Production Up

Crude oil production in Saskatchewan for the first 11 months of 1955 totalled 10,098,019.01 barrels, about double the 4,718,990 barrels produced during the same period in 1954. Natural gas production to the end of November totalled 9,810,459.19 mscf, compared to 4,054,442 mscf for the 11-month period of 1954.

New Pump Station

The Black Pool pump station on the main line of Trans Mountain Oil Pipe Line Co. system is being brought into commission.

This will increase the capacity of the main line from 125,000 b/d to a maximum of 150,000 b/d. The present shipments through the company's system are averaging 115,000 b/d.



R. G. Perry

Heads Feldman In Canada

R. G. Perry will head an expansion of D. D. Feldman Oil and Gas in Canada. The company has 22 producing wells in Canada at present and plans to expand its activities considerably during the coming five years.

Alberta Oil Shows

Southern Production Company, Inc., has encountered an oil showing in the Coalspur area of Alberta, Canada, in a wildcat well drilled to the Cardium at 8,132 feet. The well is Southern Production-Canadian Atlantic A2-3, approximately 110 miles southwest of Edmonton.

Trans Mountain Report

Trans Mountain Oil Pipe Line Co. and its subsidiaries had a net profit in 1955 of $3,086,000, or $2.05 a share on outstanding common stock. These amounts are before the benefits resulting from tax reduction aggregating $1,540,000 arising from losses incurred in 1953 and 1954.

Gas Expansion Plan

Transcontinental Gas Pipe Line Corp. has filed an application with the Federal Power Commission to expand by 105 million cubic feet the daily allocated capacity of its system. Construction would begin this summer in nine states. If early approval is given the company plans to provide 80 million cubic feet of the new capacity before the 1956-57 heating season at a cost of $54 million.

AIME Paper

Dr. Courtney Cleveland, chief geologist for Pacific Petroleums Ltd., will present a paper on "Petroleum and Natural Gas in British Columbia" at the 1956 Pacific Northwest regional conference of the American Institute of Mining and Metallurgical Engineers. Sessions are to be held at the Olympic Hotel, Seattle, May 3 to 5.

U. S. and Canadian Reserves Higher

United States and Canadian reserves of crude petroleum, natural gas liquids and natural gas increased substantially in 1955, according to estimates prepared by committees of American and Canadian associations.

Proved reserves of crude oil in the United States increased 451 million barrels to 30,013 million barrels at the year end according to the American Petroleum Institute. Reserves of natural gas liquids were 194 million barrels high at 5,439 million barrels.

In Canada the central reserves committee of the Canadian Petroleum Association reported an increase of 302 million barrels in known crude reserves to a new high of 2,510 million barrels. Reserves of natural gas liquids stood at 247 million barrels on Dec. 31, an increase of 39 million barrels. Total liquid reserves were up 341 million barrels to 2,757 million barrels.

Of the 302-million-barrel increase in Canadian crude reserves, Alberta and British Columbia reported a gain of 242 million barrels, Northwest Territories 28 million barrels, Manitoba 16 million barrels and Saskatchewan 15 million barrels.

Proved recoverable reserves of natural gas in the United States were estimated by the American Gas Association at 223.7 trillion cubic feet an increase of 12 trillion cubic feet in 1955. The AGA reserves committee found that 5.7 trillion cubic feet of new gas was discovered during the year and that 16.3 trillion cubic feet was proved up by extensions and revisions of earlier estimates. Consumption during the year was 10.1 trillion cubic feet.

Texas had nearly half of the nation's gas reserves at the end of the year with 108.3 trillion cubic feet. Louisiana was second with 42.4 trillion and New Mexico third with 18.6 trillion. Kansas followed with 16.3 trillion and Oklahoma with 13.2 trillion.

In the case of crude petroleum Texas continued to eat into its reserves in 1955. At the end of the year the API committee estimated Texas to have proved reserves of 14.934 million barrels, a loss of 49 million barrels from the previous December. Four years ago at the end of 1951 Texas had 56% of the nation's proved crude reserves with 15,315 million barrels of producible crude in sight. At the end of 1955 Texas reserves were down 400 million barrels and represented only 48% of the national total.

California made the greatest inroads into underground supplies in 1955 by producing 87 million barrels more oil than was discovered. California reserves at the end of the year totaled 3,801 million barrels and represented a little less than an 11-year supply. Substantial reserves declines were found in Mississippi, Arkansas, Pennsylvania and Indiana.

Outstanding gainer in reserves was Louisiana with an increase of 294 million barrels. New discoveries of 157 million barrels were supplemented by 382 million barrels from extensions and revisions. Production during the year totaled 245 million barrels.

Wyoming reserves were 70 million barrels higher at the year end, Oklahoma was up 61 million barrels North Dakota 51 million, Illinois 33 million and Kentucky 22 million barrels.

The following tabulation is a summary of changes in reserves:

U.S. RESERVES—Liquid Hydrocarbons

(Thousands of Barrels)

Commodity	12/31/54	12/31/55	Change
Crude Oil	29,560,746	30,012,170	451,424
Natural Gas Liquids	5,244,457	5,438,565	194,108
Total Liquids	34,805,203	35,450,735	645,532
Natural Gas (Millions of Cubic Feet)			
Natural gas	211,711	223,697	11,987

CANADIAN RESERVES—Liquid Hydrocarbons

(Thousands of Barrels)

Crude Oil	2,207,614	2,509,534	301,920
Natural Gas Liquids	208,331	247,085	38,754
Total Liquids	2,415,945	2,756,619	340,674

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New Engineering Firm

John H. Williams, president of Williams Brothers, has announced the formation of the Williams Brothers Corp., organized to handle the engineering work of various Williams enterprises.

New officials of the Williams Brothers Corp., all of whom are professional engineers, will have been promoted from the engineering department of Williams Brothers pipeline organization. They include John Williams, president; C. M. Collins, executive vice president; Vincent Butler, vice president and Wilson N. Gilliat, chief engineer.

Expansion Of Butadiene Plant

Plans for a $4,350,000 expansion program at the butadiene plant operated by Petroleum Chemicals, Inc., at Lake Charles, La., have been announced by F. M. Simpson, vice president and general manager. Petroleum Chemicals, Inc. is owned jointly by Continental Oil Company and Cities Service Company. Capacity of the plant, said Mr. Simpson, will be increased from 63,000 tons to 79,000 tons of butadiene annually. Work on the project under contract to The Fluor Corp. will start within the next few weeks and is scheduled for completion by next fall.

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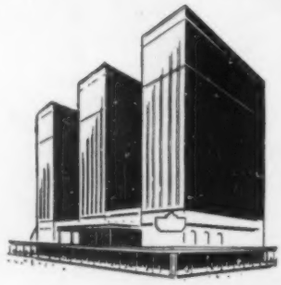

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Expenditures Hit Record Level

A series of talks by Eugene Holman, chairman, and M. J. Rathbone, president, of the Standard Oil Company (N. J.) has shown that company's earnings were higher in 1955 than ever before. Expenditures during 1956 will be a record $1.2 billion for Jersey and non-consolidated affiliates.

1955 earnings totaled $717 million or $10.96 per share, compared with $585 or $9.50 per share in 1954. Consolidated net investment at the end of 1955 is estimated at $4.7 billion.

Expenditures during 1955 by Esso totaled about $850 million on new plant and equipment for oil exploration. Increasing demand during 1956, amounting to about 200,000 b/d, will necessitate some $800 million for new capital investment alone, exclusive of replacement or modernization costs. Of the total $1.2 billion to be expended some $950 million will go to the Western Hemisphere, with $475 million to the U. S. About $150 million will be invested by consolidated affiliates in Western Europe, the U. K. and North Africa.

The increase in world demand is estimated by the company to be very large, especially abroad. In Western Europe total consumption is estimated to rise nearly two and one half times, necessitating rapid increases in Middle East production to about double present levels. Latin American consumption is expanding rapidly with a broadening industrial base and mechanization of agriculture, plus population increases. Increase in the U.S. will grow about 60% over the next 20 years and Canada will raise about two and one half times.

Jersey's investment is to be broken down to about one-half for exploration and development, one-fourth for marketing, transportation and research, and one-fourth for refining. Among the refining expansions planned are additions in Cuba and the U. K., with new plants planned in Colombia, France, Germany and the Far East. Transportation additions include 53 super-tankers at a cost of $312 million.

Westpan Hydrocarbon Stock Sold

Sinclair Oil Corp. will sell its entire holdings (384,861 shares) of Westpan Hydrocarbon Co. common stock to Jalco, Inc., of Dallas. Westpan of Amarillo has various interests in crude oil and gas production.

Sinclair will receive $12.70 a share, or in excess of $4,800,000, for its holdings which represent approximately 53% of the 727,757 shares of Westpan outstanding. Under the terms of a Securities and Exchange Commission order, based on the Public Utility Holding Company act, Sinclair is required to dispose of all its Westpan stock.

Hydrogen Peroxide Plant

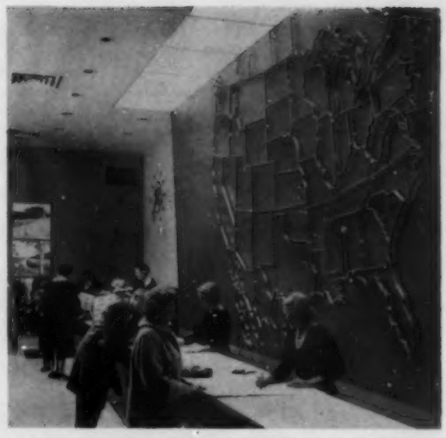
Solvay Process Division, Allied Chemical & Dye Corp., has announced that its hydrogen peroxide installation at Syracuse, N. Y., under construction for the past 18 months, has gone into operation. The new plant, which occupies an eight-acre plot, comprises a number of buildings for the various operations involved, which include synthesis, distillation and purification, packing, loading and shipping, as well as a large outdoor storage tank farm. Other facilities include the plant office as well as a wash and locker building.

Errata

Ewbank and Partners Ltd., engineering consultants, London, was in charge of engineering and design of the power plant installed at the Daura refinery at Baghdad, Iraq. The company was subcontractor for The M. W. Kellogg Co. This information was omitted from the article describing the new refinery published on page 51 of the January number of WORLD PETROLEUM.

In the December issue, the item appearing on page 76 headed "Pakistan Mines and Minerals Act" should read "India Mines and Minerals Act." The minister referred to therein is Mr. Maulana Azad.

On page 92 of the December issue, the table of earnings of 44 oil companies for the first nine months of 1955 compared with the first nine months of 1954 showed earnings for International Petroleum Co. Ltd. for the first nine months of 1954 as $10,000,000. This figure should have been $18,001,000. This changes the total earnings of the 44 oil companies for 1954 to $1,753,402.



A new street-level Texaco touring center at Park Avenue and 50th Street, New York, has been opened by The Texas Co. This photograph of the new center shows the information counter and a large grid-mural of the 48 States, which was sculptured in hammered brass by Pierre Bourdelle, sculptor. On another wall is a group of enlarged photographs of vacation areas.

Elk Hills Revision Misinterpreted

The editors of WORLD PETROLEUM received a letter from G. Stewart Brown, manager of public relations for the Standard Oil Co. of California, commenting on a report from our Washington correspondent published on page 4 of the January number. The report dealt with Standard's efforts to negotiate a revision of the Elk Hills Naval Reserve agreement. Mr. Brown's letter follows:

"The January issue of WORLD PETROLEUM carries a brief article under the heading 'Elk Hills Revision Due' which we feel is subject to misinterpretation, and we should like to take this opportunity to clarify several of the points.

"Primarily, we are concerned with the statements that the revision 'would enable the petroleum company to take out much of its one-third share of oil in the basin quickly' and, later in the article, that 'this would give the company the right to take out millions of barrels as quickly as it saw fit, if approved.'

"Both of these statements engender a basic misconception about the whole proposal, i.e., that Standard is attempting to 'open up' the reserve for large-scale commercial production. This is definitely not the case. Our plan simply proposes that Standard receive the *necessary* daily production from the Shallow Zone, ahead of Navy, until the Company's share has been withdrawn. (By 'necessary production' is meant that production which engineering studies determine is necessary to keep the wells and field in good operating condition.) At the present rate of necessary production, it would take Standard some 30 to 40 years to withdraw its share of Elk Hills, even *after* the modification proposal were effected.

"In no wise are we proposing that current production in the reserve be accelerated above that required to keep the Shallow Zone in good operating condition, as may be determined by the Operating and Engineering Committees and authorized by the Secretary of Navy. Not one barrel of oil will be produced currently under our modification proposal which would not be produced in any event under the existing agreement.

"The Naval Reserve continues as before, unchanged from the standpoint of military readiness. What we are proposing is merely a reallocation of the current necessary production, now divided eight-ninths to Navy and one-ninth to Standard. Our plan would permit Standard to withdraw its share of the reserve sooner than otherwise, and thereafter leave administration of the reserve entirely in Navy hands.

"In return, Standard offers Navy substantial consideration including the addition of 20 million barrels of underground reserve to Navy's account.

"We realize that this is a brief explanation of a very complex proposal, but we do hope we have made ourselves clear on the point that our modification plan does not in any way alter the status of Elk Hills as a Naval Petroleum Reserve."

Gasoline Taxation Studies

Federal and state governments should rely mainly on user charges (chiefly gasoline and diesel fuel taxes and, to the extent practical, tolls) to finance rapid modernization of the nation's highways, the Research and Policy Committee of the Committee for Economic Development concludes in a new national policy study.

The Committee said that while "there is no completely fair and efficient way of charging highway users for their use of the roads," the direct benefits they receive "are more than sufficient" to justify charging them, rather than the general taxpayer, for most of the cost of highway improvement. The report is the result of a year's study of the complex and controversial highway problem and relates to Federal, state and local programs to meet the situation.

Transcontinental Stock Split

Stockholders of Transcontinental Gas Pipe Line Corp. have approved a 2-for-1 split of the company's 3,530,000 outstanding shares of common stock. To provide sufficient stock to effect the split, the stockholders also approved an increase in the authorized common stock from 5,000,000 to 10,000,000 shares. Each holder of common stock will receive a new certificate equal to the number of shares held of record on Jan. 20, 1956. Following the stockholders' meeting, directors of the company declared an initial quarterly dividend of 22½ cents a share applicable to the split stock, payable Feb. 1 to holders of record Jan. 20. This represents an increase to the equivalent of $1.80 a share annually on the old stock which had been receiving $1.40 annually since dividends were inaugurated.

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Hydrogenative Process and Desulfurization Patents

(*Continued from page 67*)

nol content is at least about 2 vol. %. A sufficient amount of solution is used to form a separate aqueous phase. Treatment is followed by the addition of an amount of free sulfur effective for sweetening but insufficient to render the product naphtha corrosive. The free sulfur containing mixture is heated to 120°F to complete sweetening and the phases are then separated. According to 2,727,850 (W. E. Stanley, Jr. and J. E. Kaufman) a sour, thermally cracked naphtha is treated in a series of steps with an aqueous caustic solution containing phenolates. A method for the regeneration of this solution is described. Patent 2,727,852 (R. H. Brown) describes a doctor sweetening process, in which sour hydrocarbons are contacted with a doctor solution containing at least 20% of caustic and between 0.02 and 0.2g/100 cc of copper formed by introducing a water soluble cupric salt into the doctor solution. An amount of copper is used, which is sufficient to form separate oil and agent phases. Contact is at 70-175°F in the presence of at least the theoretical amount of free sulfur needed to convert mercaptans to disulfides and in the presence of enough free oxygen to convert all the lead sulfide.

Three Esso Research & Engineering Co. patents deal with the sweetening of gasoline, light and middle distillates, and heating oils. E. J. Nichaus (2,729,592) sweetens cracked gasoline by contact with air in the presence of a phenylene diamine inhibitor and of amonia. E. Arundale and J. P. Thorn in 2,731,393 disclose a method for treating a sulfur containing fraction of light and middle distillates with a mixture comprising an alkali metal carbonate (0.1-5 wt. %), an amine and an aldehyde. The amine (0.1-3 wt. %) may be a secondary alkyl amine and the aldehyde (0.05-1 wt. %) may be formalin solution. A method for heating oil sweetening is contained in 2,724,684 (S. B. Sweetser, S. O. Bronson and R. C. Morbeck). The oils are contacted at 550-650°F and atmospheric-400 psig pressure and in the absence of added gases with molybdena-alumina or cobalt-molybdena-alumina. The thus treated hydrocarbons are then contacted with caustic and air in a second stage.

J. A. Chenicek (2,723,944 to Universal Oil Products Co.) describes a method for removing mercaptans from distillates by reaction with isocyanate compounds. The same objective is pursued by L. M. Browning and R. M. Kauffman (2,725,339 to Socony-Mobil Oil Co.). They treat gasoline with alkali metal hydroxide particles having diameters of 1-40 microns which have been activated with an aliphatic mono-hydric alcohol, such as methanol. Sodium hydroxide can be dissolved in methanol and the alcohol is then evaporated prior to contact with the gasoline. A British Petroleum Co. patent (2,729,591 D. S. Haresnape and R. L. Denyer) claims treatment of mercaptan containing oils with an aqueous caustic alkali solution containing a substance which is capable of increasing the solubility of the mercaptans in the alkali solution in the presence of oxygen or an oxygen containing gas. Commercial creosol is a suitable solutizer. The treatment may be carried out in two or more stages.

U. S. Contract Drilling Costs

Average cost per foot of hole drilled in the United States was $13.50 during 1955, according to a survey by the American Association of Oilwell Drilling Contractors. This is based on the average depth well, which was 4,044 feet in 1955. A comparison with previous years shows that 92% of U. S. wells in 1955 were drilled by contractors, as compared with 68% in 1935. Average cost per foot is up from $8.00 in 1935 and 197% compared with 1941.

Automatic Air-Operated Tool

Ingersoll-Rand has developed an air-operated tool which will run a nut to any desired torque, then automatically shut itself off. The new tool incorporates the first application of the torsion bar principle to torque control. While the nut is being run to required torque, the new Impactool operates at normal power and speed, but when required torque is reached and nut-running resistance is equal to the stress present in the torsion bar, the impact mechanism trips a rubber-faced shutoff valve.

AAPG Convention In Denver

The recent convention of the American Association of Petroleum Geologists in Denver brought comments from several well-known members of the association. F. A. Thurman, outgoing president of the Rocky Mountain Section, pointed out the high rate of use, now over 6 billion barrels yearly in the United States. To replace this oil, he stated, necessitates discovery of a Rangely field each month or an Adena field each five days. He foresaw no shortage, however, but a need for geologists to strive for a more positive geologic thinking and a willingness to take a calculated risk.

H. H. R. Sharkey of Denver pointed out that oil exploration in the Rockies would have to rely more on subsurface studies. George R. Downs of Denver recommended more attention be paid to structures such as the zone of adjustment between mountain uplifts and basin blocks, in front of thrust sheets, above basement faults, as warps in broad basin areas, at terminal parts of mountain uplifts or arches and above igneous instrusives.

An Atomic Energy Commission geologist, Y. W. Isacksen, suggested that petroleum geologists turning to the hunt for uranium, study structural controls as well as sedimentation as clues to additional bodies of the strategic ore.

In a brief talk, G. M. Knebel, national president of the AAPG, said recent studies showed the great bulk of oil now known occurs in five typical places: 1. On the stable side of basins; 2. In anticlines; 3. In sandstone and carbonate reservoirs; 4. From formations of Mesozoic age or younger, and, 5. From a depth of 2,000 to 8,000 feet.

Nageobar Director

A. T. Robertson has been named personnel director of the Magnet Cove Barium Corp., Houston. Prior to his present appointment, Mr. Robertson was located in McAllen, Texas as a field service engineer for the company.

Oklahoma Refinery Closes

Gaseteria, Inc., will close the Johnson Oil Refining Co. plant at Cleveland, Oklahoma, on March 31, after selling the pipe line gathering system to Kerr McGee Oil Industries, Inc., Oklahoma City. The plant was one of the very early Oklahoma independent units. It was operated by the Johnson interests from 1922 until last January. Capacity is 7,000 b/d. It is equipped with thermal cracking and catalytic reforming facilities.

Ratcliffe Retires

George L. Ratcliffe, vice president of National Lead Co., retired Feb. 1, but will continue to serve as a director. Mr. Ratcliffe was the organizer of the first company devoted exclusively to servicing and selling oil well drilling muds. He was for many years general manager of the Baroid Division, National Lead Company. He was also the first to introduce a fleet of laboratory equipped field cars for testing oil well drilling mud.

National Buys Mud Products

National Lead Co. is acquiring the capital stock of Mud Products, Inc., of Tulsa, by exchange of its own shares of stock. Mud Products will continue under its present name in its normal business of distributing the products of the Baroid Division of National Lead.

Mud Products will function with its present personnel under the direction of Ben R. Bourland. Emil R. Albert, Jr., former president of Mud Products, Inc. has accepted a new position as president and general manager of Rubarite, Inc. which produces rubberized barites for use in asphalt mixtures for highways, airstrips and parking lots.

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Young Sales Corporation
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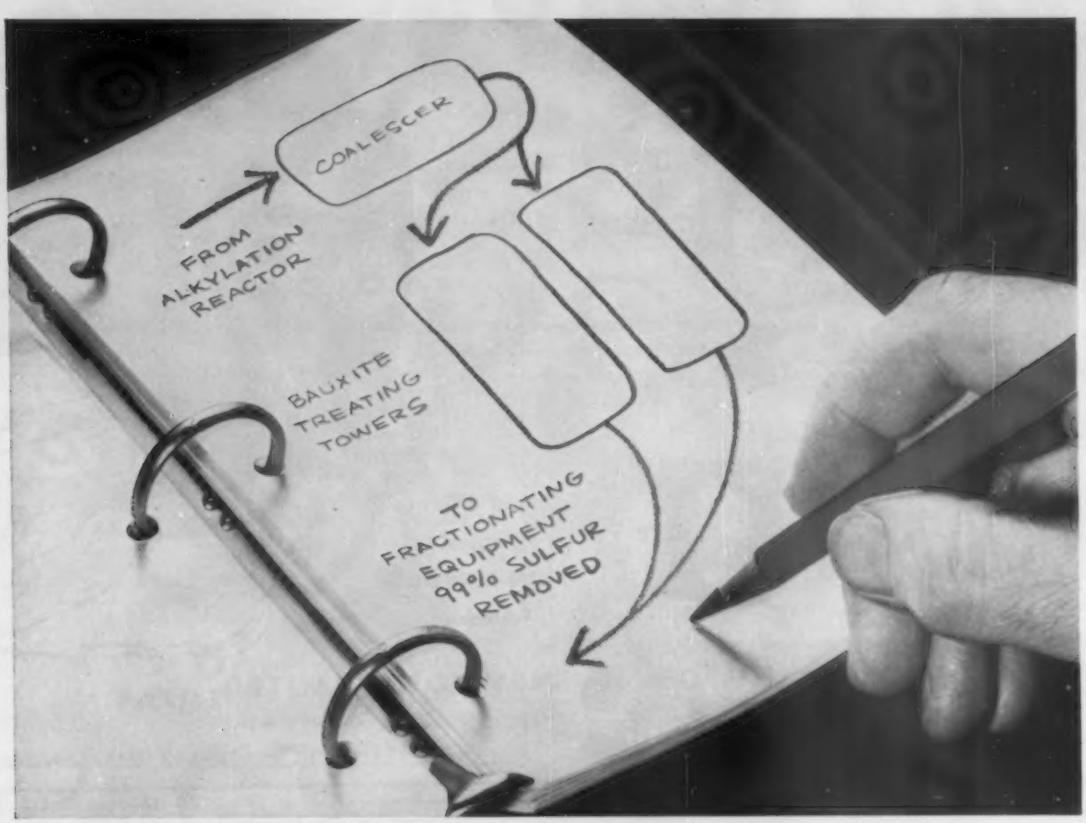

The Answer to Alkylation Maintenance

New bauxite process removes 99% sulfur from alkylation reactor effluent

Reduced corrosion, decreased fouling in alkylate fractionating units, and savings in tetraethyl lead result from a new bauxite process of treating reactor effluent which has been developed jointly by D-X Sunray Oil Company and The M. W. Kellogg Company.

Sixteen months' experience with this process shows that it removes 98 to 99% of acid and both acidic and neutral esters from the alkylation reactor effluent. This compares with 65% sulfur removal obtained in conventional caustic wash systems.

The new bauxite process uses a coalescer to provide the equivalent of added settling time. This horizontal vessel separates suspended microscopic drops of acid and sulfur hydrocarbons. The effluent then percolates down through medium mesh bauxite in one of the two treating towers, where acid and esters are preferentially adsorbed. The towers are alternately regenerated.

This new process not only eliminates maintenance problems caused by residual acid, but also saves tetraethyl lead, due to the improved lead susceptibility of the sulfur-free alkylate. Additional advantages include lower acid consumption and elimination of inhibitors.

The process is licensed by The M. W. Kellogg Company. Design data are available for five standard sizes, ranging from 5,000 to 25,000 bpsd. of reactor effluent.

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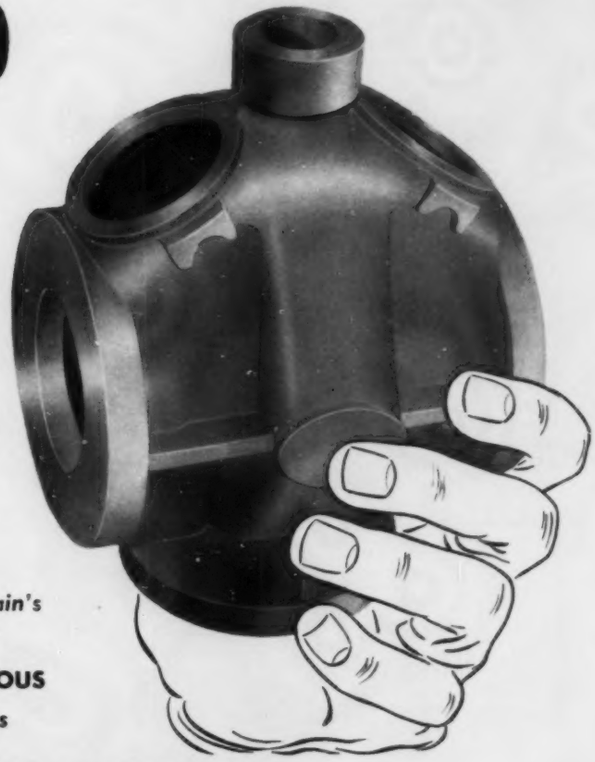

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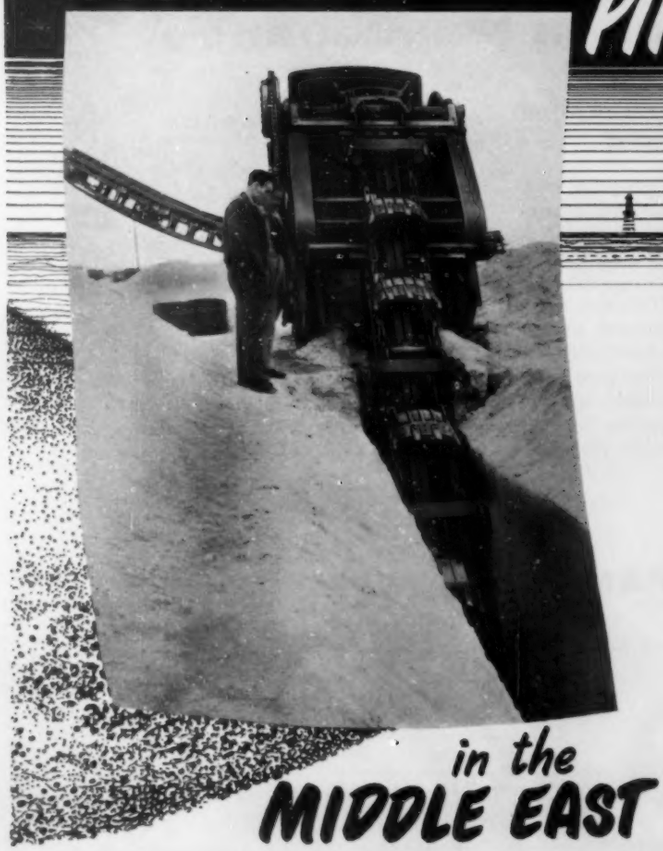
PIPE LINE TRENCHING



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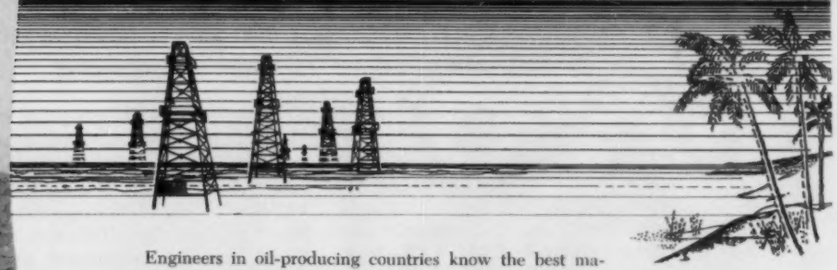

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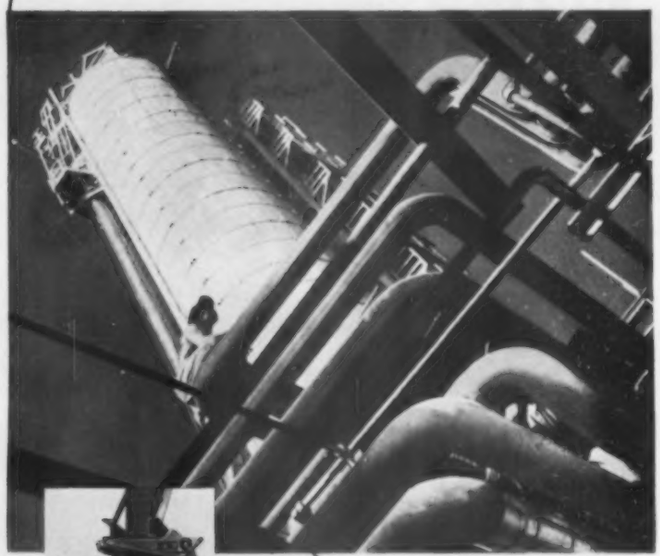
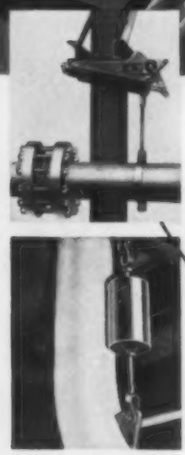
Photograph by courtesy of 'Shell'

For world-wide oil pipe suspension – VOKES GENSPRING pipe hangers

Throughout the Platforming Unit at the 'Shell' Stanlow Refinery in Cheshire, VOKES GENSPRING Constant Support Hangers are supplying their own incomparable type of support for the piping. Similarly in Aden, where the British Petroleum Company's new refinery came on stream just a year ago, VOKES GENSPRING hangers are used to provide accurate and safe pipe suspension.



Photograph by courtesy of The British Petroleum Company, Limited



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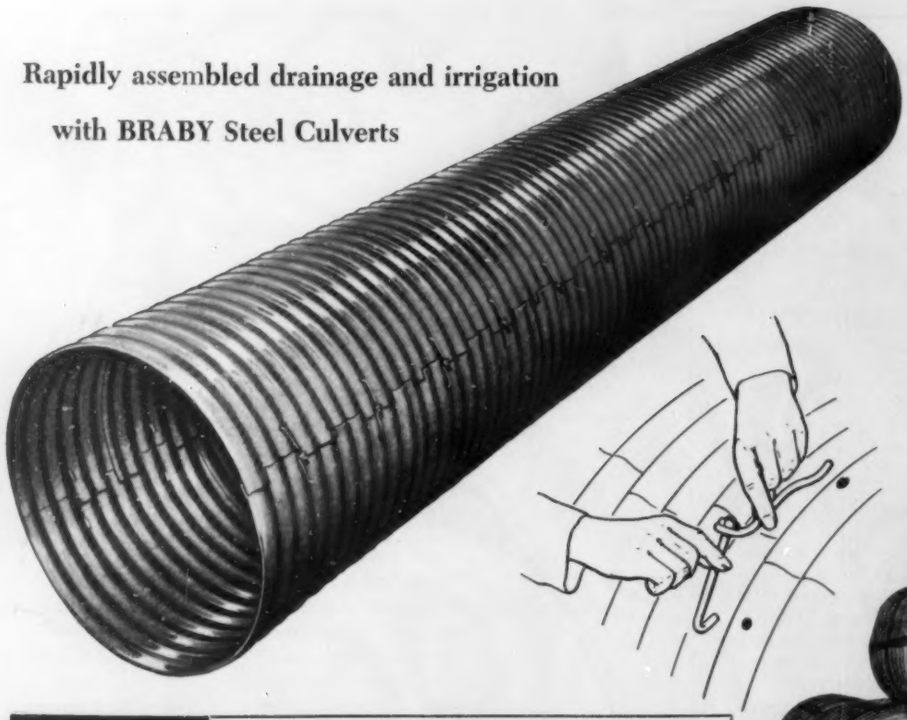

These galvanized corrugated steel culverts are manufactured in standard diameters from 12in. upwards and in thicknesses from 18 g. to 10 g. The Units designed for economical shipment, are easily and securely fitted together on the site. A leaflet with details and instructions will be forwarded on request.

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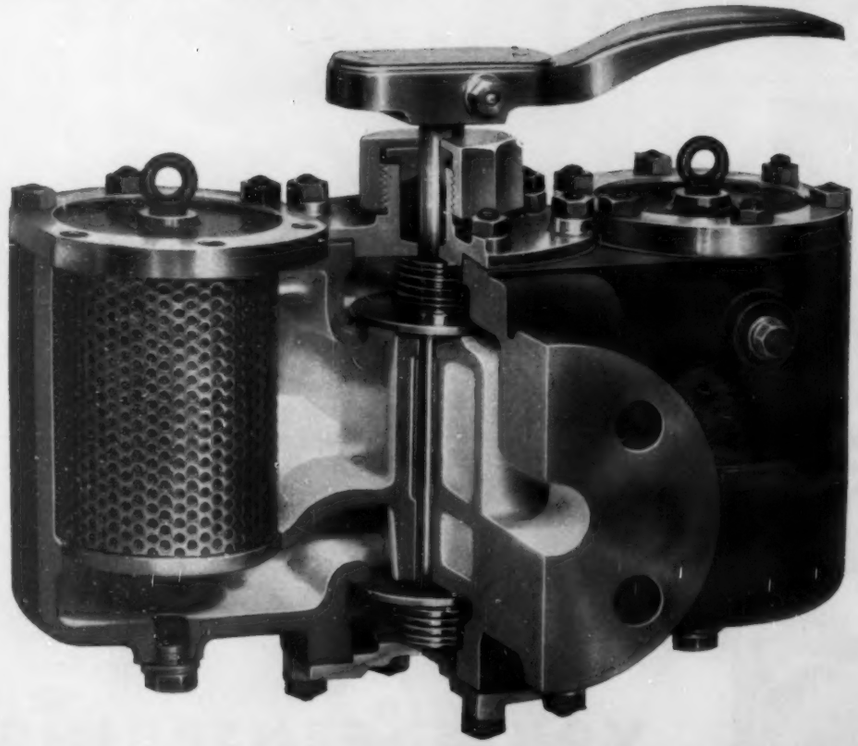

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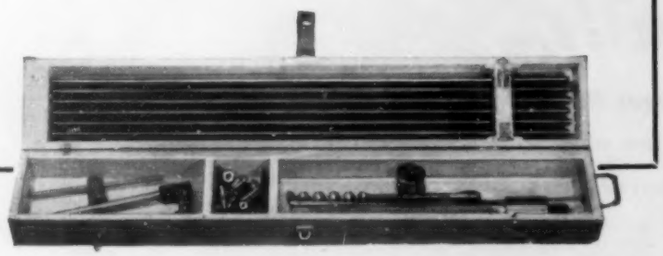

Specifications—Net weight of tools 54 lbs.; Weight of case with tools 84 lbs.; Shipping weight 107 lbs.; Size of case 4 ft. 5 ins. x 11 ins. x 8 ins.

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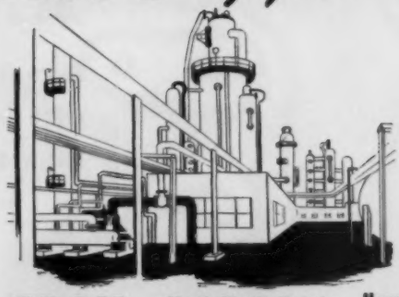
Tube Supports



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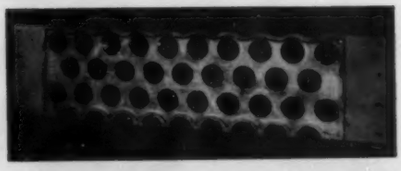

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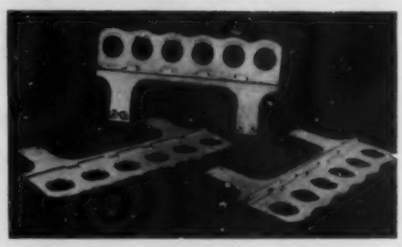

"TROPIC" Steels are available in Sheet, Plate and Bar Form, also Forgings for making up into ancillary equipment.
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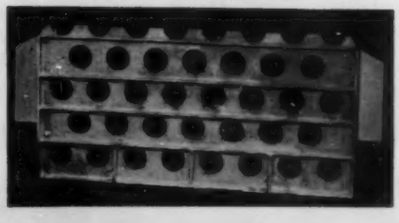

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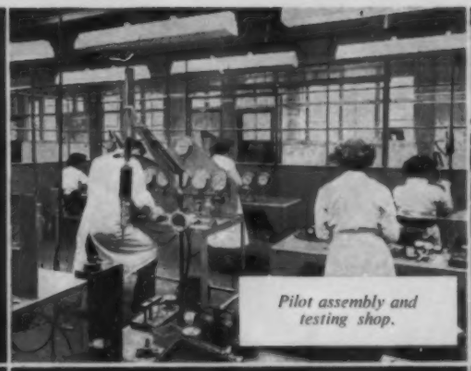
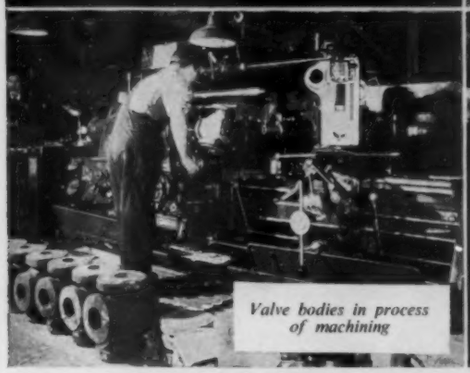
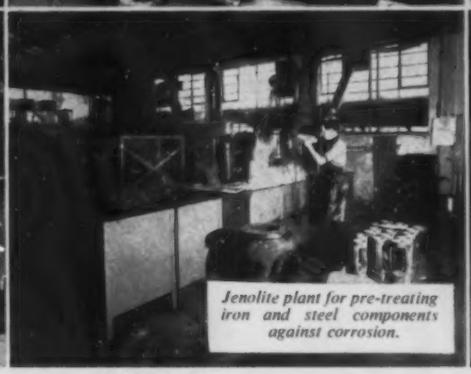


Pilot assembly and testing shop.

Pressure and hysteresis testing bay.



Valve bodies in process of machining



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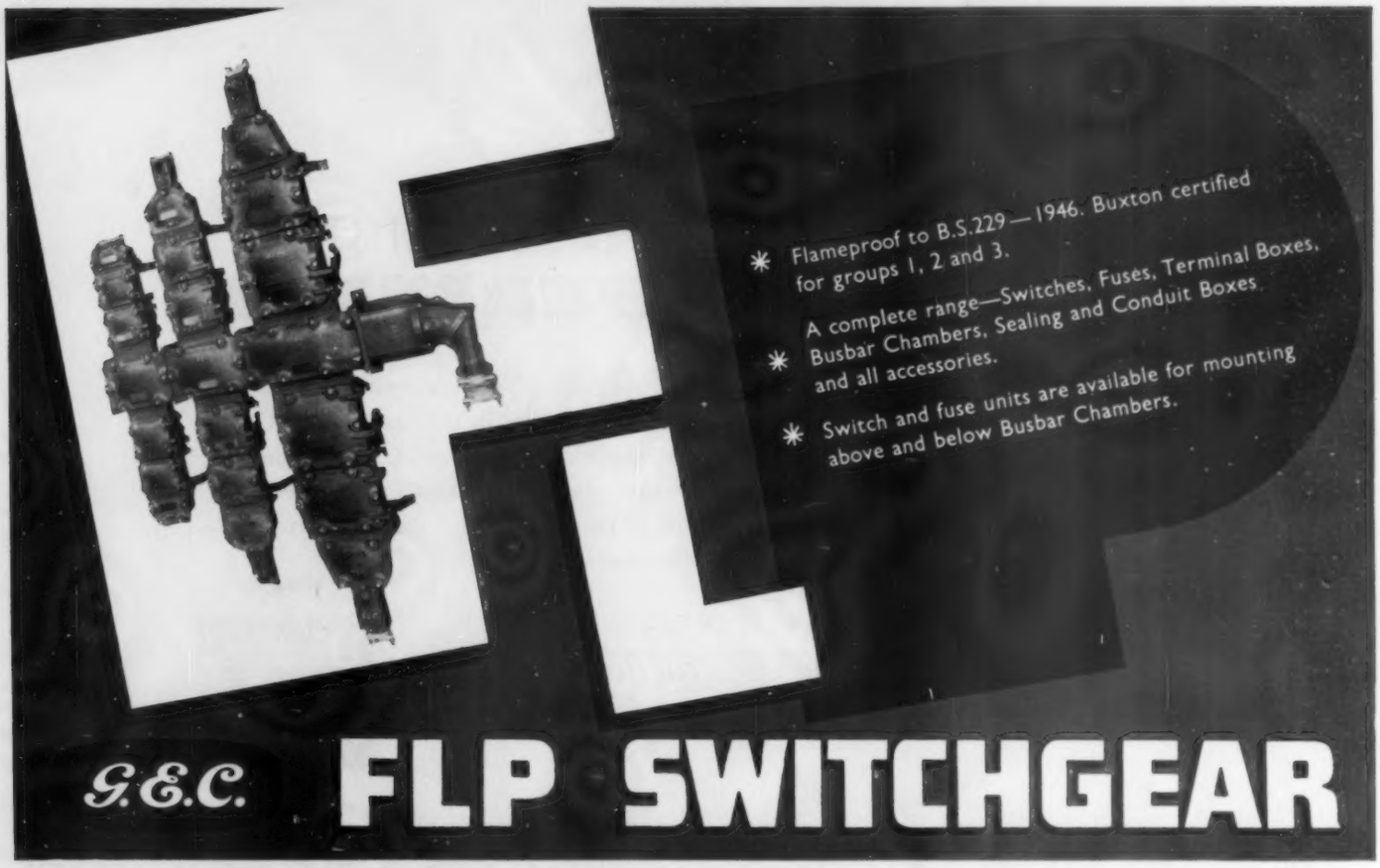
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A series of descriptions to demonstrate Cochran craftsmanship.

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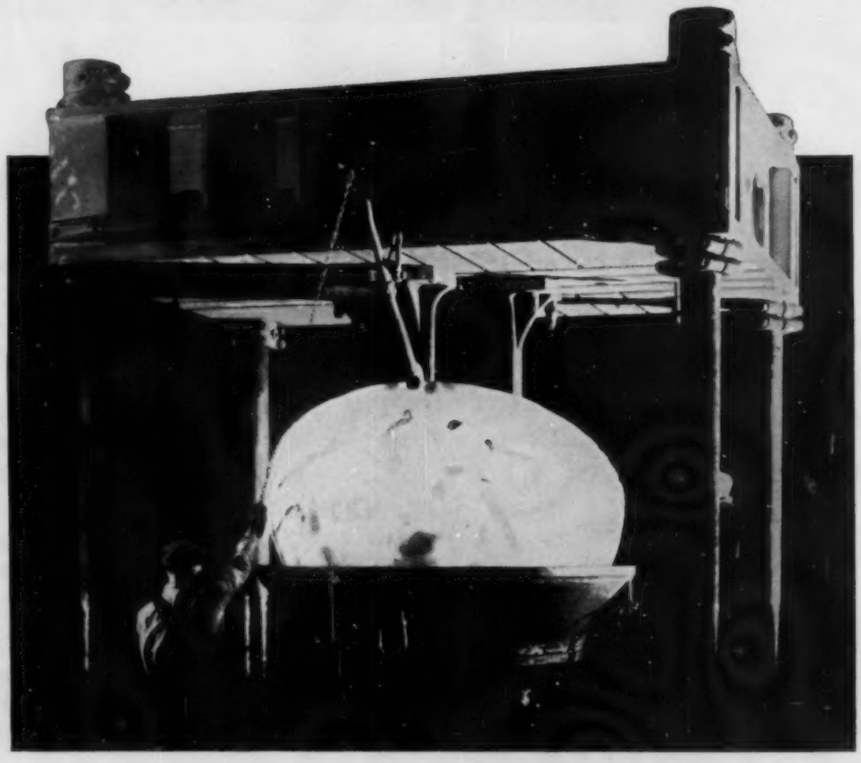
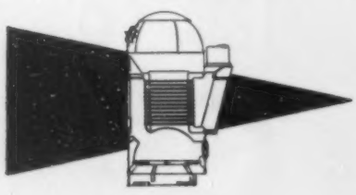


COCHRAN boilers are built from the finest quality Siemens-Martin mild steel plates. The furnace crown, as shown, is pressed from one plate and reaches hemispherical form without weld or seam; this process may require as many as nine heats. By similar hot pressing operations the tube-plates and ogee ring are formed. Whenever a plate is locally heated for shaping, the whole of it is thereafter annealed. Constant observance by skilled craftsmen of best boilermaking practice underlies much of the success of the COCHRAN boiler.



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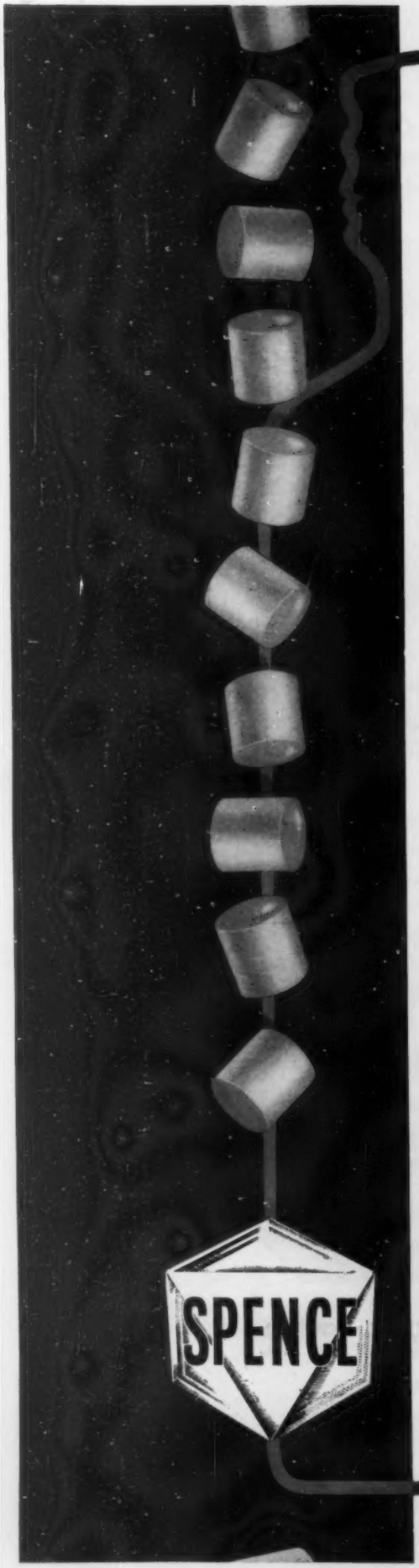

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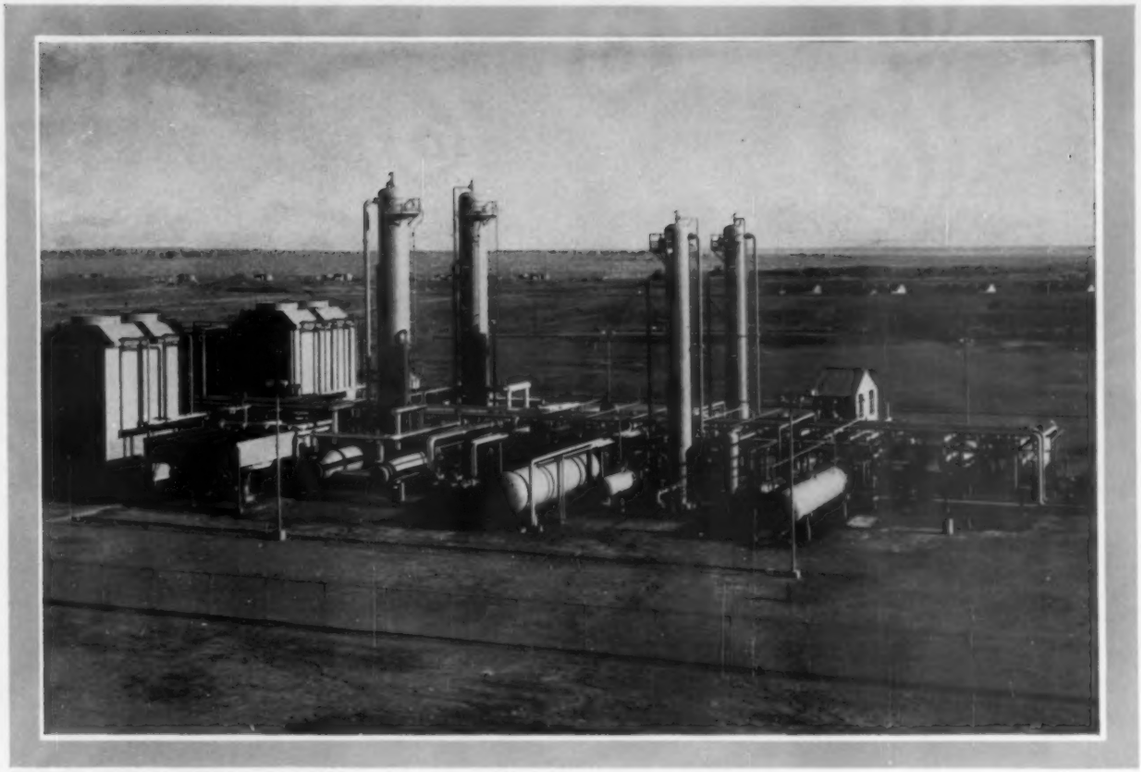

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November 4, 1955

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of Service that has
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JM.

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The assistance which your organization rendered us was a tremendous contribution in solving our problems on the Kaplan well fire.

While watching Kinley's fire fighting crew at work on Wednesday, I was especially impressed with the skill and experience of Mr. Richards and Mr. White of your organization, who were down in the pit with Kinley and his crew. They certainly know their business, and were a wonderful asset.

Also, the transportation you provided with the Twin Engine Aero Commander worked out just right, and I want to tell you how very favorably impressed I was with your fine Pilot. He couldn't have been more considerate and cooperative.

My sincere appreciation and thanks for your help.

Sincerely yours,

Harry Hurt

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